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Conducted by MAJOR B. BADEN-POWELL, F.R.A.S., F.R.Met.Soc., and E. S. GREW, M.A.

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"Ribbon" or "Band" Lightning.

By WILLIAM J. S. LOCKYER, M.A., Ph.D., F.R.A.S.

(*Continued from page* 119.)

Coming now to the second instance of a "ribbon" flash having been photographed, this was taken by Herr Georg A. L. Rumker, at 6h. 35m. p.m., on August 23, 1898, from the Hamburg Observatory. The photograph is reproduced here in Fig. 5, and is from a glass positive kindly forwarded at my request by Herr Rumker, to whom I should like here to express my thanks. Fortunately, in this picture, we have an image of a window frame, although it is blocked out in the illustration which accompanies his description of this flash (*Himmel und Erde*, XI. Yahrgang, Heft 3, p. 134, 1898). In this case also no mention is made as to how the camera was placed during exposure, so it is left to the reader to make his own deductions as to whether a camera movement took place or not. I found it, however, very difficult to make up my mind whether this flash was photographed with a camera quite still, for there are some points in the illustration which seemed to me at first to be indeterminate unless one could examine the window sill from which the flash was photographed. The first peculiarity which attracts one's attention is the light, shadowy image parallel to the right-hand side of the window frame. Is this the shadow of the window frame thrown on the glass caused by the light from the discharge? If it is, then I think we may consider that the camera was at rest and the flash a real instance of a "ribbon" discharge. If it is not, then may it not be another image of the window-frame caused either by the window having moved a little, or by a movement of the camera? If the former be the case, then the flash still remains a true "ribbon" discharge. If, however, the latter is responsible for the image, how, then, can it be explained that some and not all of the individual flashes, which make up the discharge, are not hidden by the upper portion of the window-frame?

From these and other considerations I am led to think that very probably the window was capable of being moved slightly by the wind while the lens was being exposed. Such a movement could easily occur if the catch which held the window open had a little play in it. The fainter image of the window-frame could then have been impressed on the plate by flashes which did not appear in the field of the lens, while the stronger one, nearly superimposed on the weaker one, could have been recorded by the flash shown in the photograph. No statement is made, unfortunately, as to how long the camera lens was left uncovered.

Granting, then, that in this picture we have an instance of true "ribbon" lightning, we need only briefly note some of the chief features displayed, since the flash presents nearly the same peculiarities as that obtained by Professor Kayser. We see the individual discharges distinctly, all following exactly parallel courses, and one of them on the right has a streaky appearance as if smudged in the direction right to left.

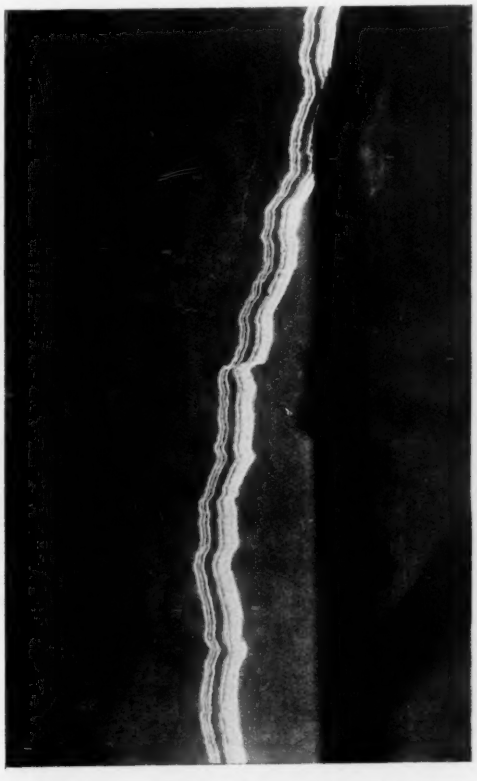


Fig. 5.—Ribbon flash, photographed by Herr Georg A. Rumker, on August 23, 1898, at Hamburg.

While these two excellent examples are in the mind of the reader, it may be as well, before describing some other more doubtful instances, to explain if possible the cause of this "ribbon" appearance.

It is perhaps as well to recall first of all three important facts relating to lightning flashes which have been conspicuously brought out by the use of moving cameras, to which I have previously drawn attention.

The first is that the ordinary discharge, which has generally been considered to be a single flash, is most commonly of a multiple nature; that is, it is composed of a series of several separate flashes, which follow

one another in the same air-channel or track made by the first discharge.

The second fact is that quite appreciable time intervals elapse between the first and last of the several individual flashes which compose a multiple discharge.

The last fact is that in many cases each individual flash heats so intensely the column of air through which it passes that the air along this track is rendered incandescent, and is sometimes sufficiently bright to record a trail on the moving photographic plate even after the actual discharge (which is momentary) is over.

Now the above three facts, and more especially the first two, become of considerable value when "ribbon" flashes are concerned, because they explain in a very simple manner the cause of their breadth.

Instead of the camera being moved, we have only in these instances to suppose that the wind, as it must do, moves the vertical air-column through which the separate discharges pass, and the multiple structure of "ribbon" flashes becomes at once obvious.

Fig. 6.—Apparently a "ribbon" flash, but landscape indicates vertical camera movement. Photograph taken by Herr Paul Reinicke, at Rudolstadt, Thüringen, on July 29, 1900.

Again, the fluffy appearance on one side of a single discharge seen in each of the above illustrated flashes is also readily accounted for. The individual flashes connected with this streaky structure in each case were the brightest of the series, and these alone were evidently intense enough to render the air-column highly incandescent for a brief interval of time. As this air-column was moved by the wind in a horizontal direction its brightness was sufficient to leave a trail as it passed over the sensitive plate. Such an explanation satisfies, I think, all the peculiarities of these two "ribbon" flashes.

In his description and statement regarding the origin of his "ribbon" flash, Professor Kayser was led to deduce that the "ribbon" appearance was due to the multiple nature of the discharge combined with a moving air-column. Such an explanation stated at a time when few, if any, photographs of lightning flashes were in existence, shows how correctly he diagnosed the case he had to deal with. To put his explanation to the test, he calculated the actual breadth and duration of the ribbon flash. Knowing approximately the distance of the flash (350 metres), and the focal length of his camera objective (0.18 metres), he determined that 1 millimetre on the plate corresponded to 2.817 metres, so that the distances between the four chief discharges were as follows: 3.08; 0.35; and 0.63 metres, or the width of the ribbon was 4.06 metres

Estimating the wind velocity as 30 kilometres per hour, or 8.5 metres per second, the time intervals between the four discharges were calculated to be 0.362, 0.041, and 0.074 seconds, or, in other words, the whole flash lasted less than half a second. These quantities he considered quite reasonable, and therefore the explanation a plausible one. It is interesting to remark that Professor Kayser refers to the streaky portion of the "ribbon" flash as "most interesting and mysterious," but leaves, as he states, the explanation of its origin alone until more lightning photographs have been secured. We see now, however, that the trail of the incandescent air-column explains simply and efficiently this peculiar feature.

Professor Kayser held, and perhaps still holds, the opinion that the flashes which composed the whole ribbon discharge were of an oscillatory nature, that is, they went backwards and forwards alternately from cloud to earth and from earth to cloud. He considered that it was improbable they were all cloud-to-earth discharges. This point is of interest because, although I have shown in this journal (Vol. III., December, 1906), that both cloud-to-earth and earth-to-cloud discharges do actually occur in Nature, I have further suggested that multiple flashes taken with moving cameras do not seem to indicate this oscillatory character.

I have now indicated that a true "ribbon" flash taken when the camera is fixed is caused by a "multiple" discharge of lightning occurring in a column of air, which column is either sufficiently near to the camera or moving with a great enough velocity to be recorded on a different portion of the plate.

Before proceeding further reference may be made to a case, the only one with which I am acquainted, where flashes were *observed* to be passing down the same track, while the track itself was recorded to have been moving. The instance in question serves incidentally as a very good example of the observation of a "beaded" discharge, a type of flash I have previously described. In fact, it seems that it was the *continued*

glowing of the incandescent air in this case that made it possible to detect the motion of the air-channel.

The instance to be cited was communicated by Professor Reimann, to the *Meteorologische Zeitschrift* (Vol. XXII., August, 1905, p. 361), and gives the account described by Herr Troche, who observed a storm which occurred on July 3, 1905. He wrote:—

> "An intense bright golden flash, which went from left above to right below, but did not reach earth, but ended in the sky above a house lying opposite. There followed in the same path, with all the identical curves, a violet-coloured flash. It was composed of a series of single parts, which were as numerous above as below, and belonged to the 'beaded' class of lightning flashes. It lasted at least a second. During this time it moved itself along its whole length sideways toward the left, so that it looked like a rocket moved by the wind! The duration agreed completely with that of the wind, which could be determined by the direction of smoke which was at right angles to the line joining the eye to the end of the lightning flash. . . ."

Attention will now be paid to one or two instances which have been described as "ribbon flashes, but which I think are due to camera movement.

The first is that which was described and illustrated in the *Meteorologische Zeitschrift* for February, 1901, by Dr. G. Lachmann. By the kindness of Herr Paul Reinicke, who took the photograph, I am able to reproduce the photograph here (Fig. 6) having received by request from him a glass positive taken direct by contact from the original negative. The photograph was secured on the evening of July 29, 1900, between 10 and 11 o'clock, during a storm which passed over Rudolstadt, Thüringen.

Fortunately, in this photograph, terrestrial objects fall in the field so that it is possible to try to find out whether the camera was really stationary or not, since no mention is made in the published account as to how it was placed. Omitting any reference to the trees for a moment and confining one's attention to the chimney pot, one is led to conclude that the sides which are vertical are more or less sharply defined, while the horizontal portions are decidedly fluffy. This indicates that probably the camera was capable of motion (or shake) in the vertical direction. Although trees, as I have previously stated, are not good criteria to deduce camera motion from, yet they give the appearance of being decidedly more blurred on their upper portions, thus corroborating the above conclusion.

One is inclined, therefore, to consider the "band" or "ribbon" nature of this flash as due to movement of the camera because the flash is broadened also *in the vertical direction*, the same direction as the blurred image of the chimney stack.

While one is led to believe that we have here a case of a multiple flash taken with a moving camera, this photograph, so far as I am aware, is absolutely unique from another point of view. It will be remembered that in both Kayser's and Rumker's flashes, all the individual discharges were parallel to each other. If the present photograph be carefully examined it will be seen that in the broad horizontal series of discharges all the individual flashes are parallel to each other up to a certain point. After this point, one discharge, most probably the last of the series in point of time, gradually leaves the original track and proceeds on a new one by itself. This seems to indicate that the wind must have so disturbed the main air-channel at this point before this, the last discharge, had reached it. The discharge had therefore to make a channel for itself, and thus took another direction which offered the least resistance to it.

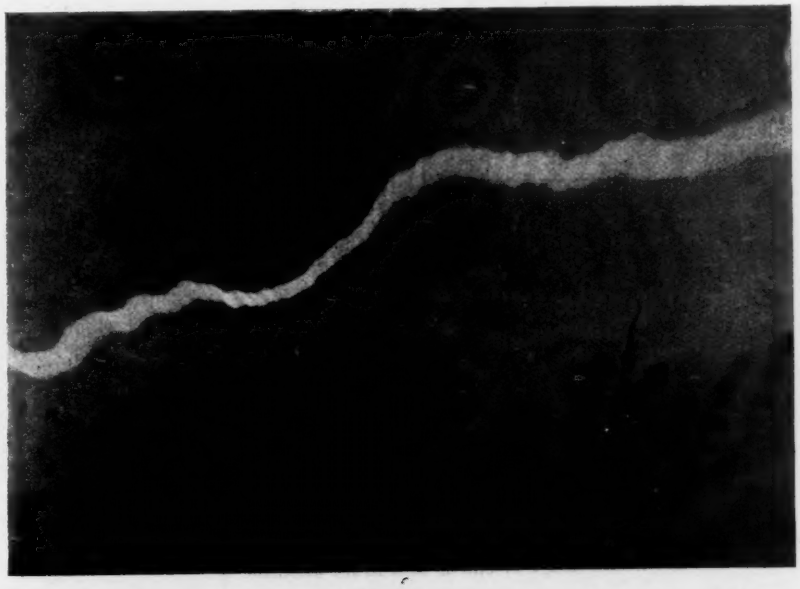


Fig. 7.— A curious flash, the peculiarities of which are as yet unexplained. Photographed by Herr Theo. Finmann, at Bahrenfeld-Alton, on May 26, 1901.

The last specimen of what appears to be a "ribbon" form of lightning flash, which will be placed before the reader, is one which was secured by Herr Theo. Finmann, on May 26, 1901, at 9 p.m., at Bahrenfeld-Altona-Elbe. It is described and illustrated in the *Meteorologische Zeitschrift* for December, 1901. The photograph was obtained from the balcony of his house, and he states that his camera "stand geoffnet fest," or, in other words, it was stationary. There was very little wind at the time, and the flash went from north to south, the camera being directed towards the east.

To find a satisfactory explanation of the peculiarities of this flash has puzzled the writer for a long time. Even now no solution is offered, and I leave it to my readers to tender an explanation. There seems little doubt that the lightning discharges are very much out of focus for the fainter vertical flash near the middle of the photograph indicates this to a very great

extent. The comparative sharpness of the leaves of the tree near the camera suggests also that while near objects were sharp, distant ones would be out of focus. The particular ropy nature of the large flash on the right-hand side has also an exceedingly out-of-focus look. A feature difficult to explain is the varying direction of the apparent folds in the ribbon, all of which seem to converge to a point near the horizon. Movement of the camera could not produce this effect. Might not this be explained by the use of an inferior lens?

In spite of the apparent anomaly that this photograph presents, I do not think that we should consider that the discharge was other than an ordinary one. So many peculiar features can be so easily secured by means of cameras, that one must attribute the peculiarities to the photographer and his apparatus rather than to the lightning itself.

Lyme Regis Landslip.

A LANDSLIP took place at Lyme Regis on June 10th, which, owing to certain phenomena of flame and smoke accompanying it, gave rise to many fantastic rumours concerning a supposed volcanic origin. The slip took place about two o'clock in the afternoon, below the road which leads from Lyme to Charmouth. The ground here consists of Greensand in the upper part, and of Lias shales in the lower part, the latter forming a succession of cliffs and terraces from a height of about 300 feet down to the beach. There are three tiers of cliffs, and it is the middle one for a distance of about 500 yards (rather more than a quarter of a mile) which is the scene of the slip. A great slice of this cliff suddenly gave way, and slid into the sea with a loud rumbling noise and the production of semi-circular waves in the water. The slice intersected a mound of burning clay, and Mr. Cameron, a well-known geologist, resident at Uplyme, states that the interior of the mound thus disclosed resembled an old brick-kiln, from the baked appearance of the clays and shales. Falls from the cliffs continued all the afternoon, and the whole range of cliff is still in an unstable condition. It is hardly necessary to say that there was nothing volcanic about the occurrence. Spontaneous combustion took place at one point owing to the decomposition of iron pyrites and the rapid oxidation of the iron. As some of the shales contain lignite, and others may be more or less bituminous, combustion is always likely, and the mound of smoking shale has been noticeable from the beginning of the year.

WHITE-BEAN AREA SCALE.—From Messrs. Casella we have received one of their White-Bean area measuring scales. It is a scale made of transparent celluloid, with parallel rulings indicated on it. In order to measure an area, the scale is laid over it, and the limits of the area both latidudinally and longitudinally with respect to the ruled lines are noted. The system of notification is a very simple one, and the dimensions of the area are quickly arrived at by reference to accompanying scales. It is an ingenious scale, and with its aid the area of any irregular figure can be measured in a very rapid and convenient manner, with a sufficient approach to exactness for most practical purposes.

The Meteor Crater of Canyon Diabolo.

NOT far from Canyon Diabolo, in Arizona, is a remarkable crater-form depression which has lately been the object of close examination, and concerning which the suggestion was made as long ago as 1896 that the depression might have been caused by the impact of a meteoric fragment of great size. The depression exists in a region where there are no other signs of volcanic action or any suggested origins for them, and the mere existence of a crater some three-quarters of a mile in diameter and 500 feet in depth in a region of undisturbed sedimentary rocks is in itself enough to invite scientific inquiry. When the suggestion of its meteoric origin was first made, the hypothesis was rejected as too fanciful. Further investigations have re-opened the question, and Mr. George P. Merrill, Head Curator of Geology, U.S. National Museum, has just published in the Smithsonian Miscellaneous Collections a series of observations which treat the original suggestion with the greatest respect, and furnish weighty reasons for believing it to be a credible explanation of the crater's origin.

The crater, which is a depression within an elevated rim of limestone and sandstone, has become generally known as Coon Butte, or Coon Mountain—though it occurs in a region where racoons are rarely known, and though the elevation is neither a mountain nor a butte. At best, the elevation is but a low circular ridge, and in the existing state of our knowledge might well be named Meteor Crater. If it were viewed from a balloon it might conceivably resemble the photographs which Professor Worthington has made of the splash of a drop; or the impression which a steel shell makes on piercing or partially piercing an armour plate. As seen from the railroad and other points within a few miles, the crater rim rises above the level of the plain in the form of a low hill with peculiarities of contour and surface configuration that at once catch the eye of the observant and serve to differentiate it from the surrounding mesas. A near view shows the mass of the crater rim (as the hill proves to be) to be composed, so far as visible, of loose, unconsolidated material in fragments of all sizes, from microscopic dust to blocks weighing hundreds of tons. The jagged nature of the ridge increases until the summit is reached, where a full view of the phenomenon and its surroundings is obtained (see Figs. 1 and 2). The view from this point, particularly about sundown or by moonlight, is weird and impressive in the extreme. The inwardly steep and even overhanging walls, profoundly shattered, surrounding on every side a broad, deep pit, accessible only by the steepest of trails, barren of all but the scantiest of vegetable life, and gashed by torrential action, present a picture which, when one reflects on its probable origin, is never to be forgotten. The crater walls are composed of the crushed, broken, and bent strata of the limestone and sandstone forming the floor of the surrounding plain, and which dip away from it in all directions. In other words, the structure is that which is known as quaquaversal. The crater rim is at its highest point 160 feet above the plain, according to Mr. Barringer, and at its lowest 120 feet. In outline, the crater is itself nearly circular, though

showing numerous minor deformations. The diameter along an east to west line is given as 3,950 feet; along a north and south line as 3,850 feet; and the depth as approximately 600 feet from the crest of the rim, though, as will be noted, this is considerably short of the original depth.

The crater rim is composed on its outside of loose fragments of material, mostly angular, and beyond question derived from what is now the crater interior masses of sandstone, from the finest rock dust to those weighing hundreds and even thousands of tons. The larger blocks are of limestone, but this is because the sandstone "weathers" far more easily and quickly. Perhaps the most significant feature of the masses of scattered *débris*, which spread out in gradually-diminishing quantities for distances varying from a quarter of a mile to a mile (and in some instances to a distance of $3\frac{1}{2}$ miles from the crater's rim), is the occurrence of the enormous masses of the sandstone which have undergone a partial metamorphism through crushing and heat. It is sufficient to state that their material must have come from a depth of at least 300 feet below the original surface. A glance at the interior walls of the crater shows at once its nature if not its origin. They consist of strata, principally of the limestone, but locally of the sandstone, also crushed and shattered to an extraordinary degree and dipping away (outwards) on all sides, and, in one instance, with an overturn of at least ten degrees from the vertical. The walls are steep, and often overhanging. For hundreds of feet they are accessible only to birds, and are of so loose and crumbly a character as to make exploration dangerous. A single false step may set tons of loose material slipping and plunging down the steep steps. The illustrations (says Mr. Merrill) utterly fail to convey an idea of their impressive as well as dangerous character.

The crater's minimum depth of 600 feet below the level of the rim gives it a depth of about 440 feet below the level of the plain. Beyond the fringing reef of fallen rock material the floor presents a nearly level plain of 300 acres in extent. It needs but a glance, however, to show that a large amount of material has fallen from the interior walls in the course of many years and that the original depth must have been considerably greater. A number of drill holes have lately been sunk up to depths of 1,100 feet in the floor of the crater, and we give below the results of one of these borings, which is typical.

	Depth in Feet.
(1) Surface material, soil, sand, and wash from cliffs ..	0- 27
(2) Lake bed formations, lying horizontally and containing diatoms, shells of molluscs, and abundant gypsum crystals	27- 88
(3) A sand which gives reaction for nickel and iron, and contains fragments of metamorphosed sandstone, sandstone pumice, etc.	85-220
(4) Sand and rock, sand grains crushed slightly, if any, and not metamorphosed, barren of meteoric material	220-520

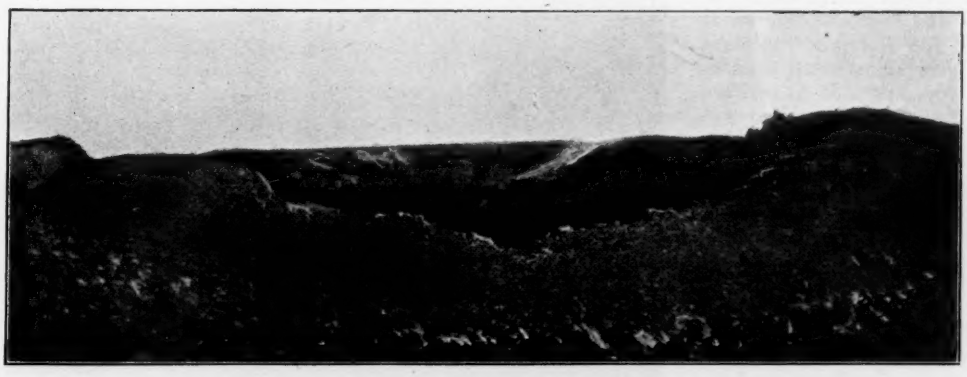


Fig. 1.—Looking across the Crater from Northern Rim.

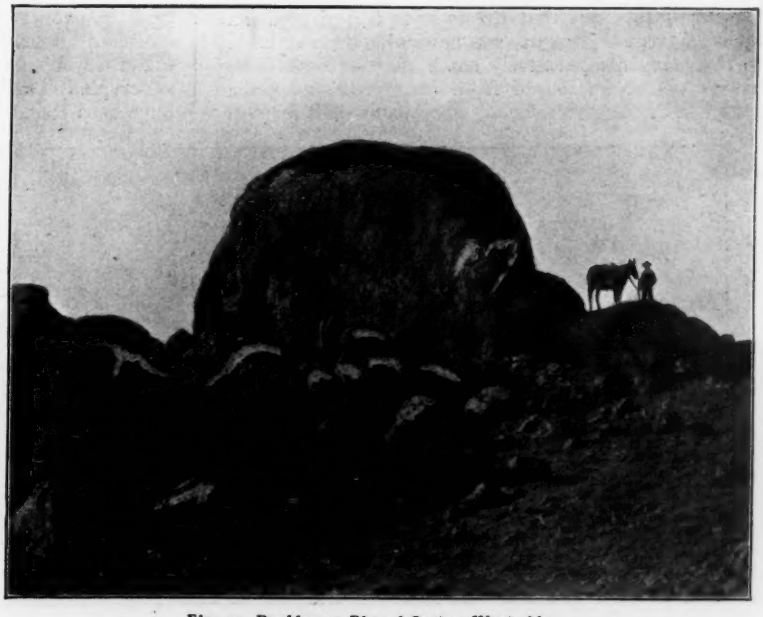


Fig. 2.—Boulder on Rim of Crater, West side.

	Depth in Feet.
(5) Sand and "silica" (rock-flour), with abundant slag-like material containing iron and nickel, and metamorphosed sandstone	520-600
(6) Fine silica powder (rock-flour) and sand, no meteoric material	600-620
(7) Bed-rock, a greyish sandstone rapidly becoming yellow and harder, not metamorphosed	620-720

The yellow to red sandstone, which seems everywhere to form the floor of the crater, was first struck at a depth of 820 feet. Meteoric material (material containing metal and iron) was first encountered at a depth of 180 feet, and continued with few exceptions in all samples down to 600 feet. It is evident that the bottom of the crater was occupied at one time by a shallow lake, in which lived diatoms and fresh-water molluscs, and on the bottom of which accumulated during periods of drought the deposits of carbonate of lime and gypsum, so characteristic of some Western lakes.

One of the features of Canyon Diabolo, which gave it a distinction apart from the "meteoric crater" theory, was the presence of fragments of undoubted meteoric material, the discovery of which was announced as far back as 1891. The interest in these was maintained by the fact that minute fragments of diamond were detected in the meteoric stones thus found. These specimens have become internationally famous, and a diamondiferous meteor from Canyon Diabolo was for some time in the possession of Sir William Crookes, and can be seen in London at the present time. The exact number of independent masses of the iron that the locality has yielded and their aggregate weight can never be known, owing to the many comparatively small pieces carried away by visitors or purchased from Mr. Voltz, an Indian trader in the neighbourhood, who has made it a matter of business to search for them, even hiring men and boys and ploughing the ground over certain areas. An estimate of the total weight, which can be considered little more than a guess, is 20 tons, while the numbers run up into thousands, weighing from not over a gram to 460 kilograms (1,013 pounds) each, the latter weight being that of the large specimen in the Field Museum at Chicago. The irons are characterised by deep concave and convex surfaces and peculiar pittings or holes, an inch or more in diameter, which sometimes extend through the mass, and are commonly regarded as due to the oxidation and crumbling away of nodules of iron sulphide (troilite). Each iron seems to form a complete individual, with no visible signs of rupture from a parent mass. These irons have been found scattered about the crater. One piece, it is said, was found eight miles from the crater, another (rather apocryphal) twenty miles south. Only three or four have been found inside the crater. They nearly all lie

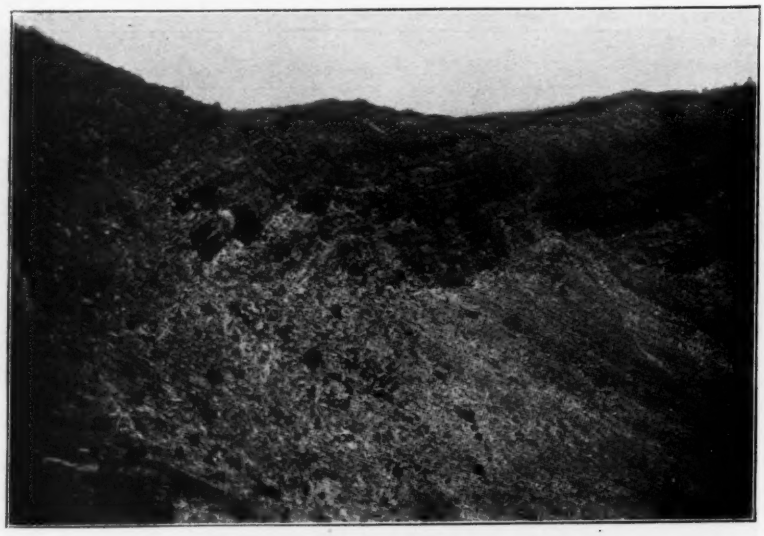


Fig. 3.—Interior Wall of Crater, looking Northward.

Fig. 4.—Interior of Crater, showing nearly level floor, looking South.

on the surface; and their distribution seems to show that if the crater was formed in the way supposed, the falling mass came from a direction a little north of west. Scattered over the surface of the plain, like the irons, are abundant masses of brown oxide, with a shaly structure. There is also on the northern side of the crater rim a quantity of so-called "shale balls," which are composed of masses of incompletely oxidised iron.

So far as shape is concerned, the crater could have been formed equally well by blow-out or by impact. The character of a portion of the ejected material points strongly, however, to an origin by impact. How else are we to account for the smashing and metamorphism of the sandstone?—or the comparatively undisturbed and unchanged condition of the deeper-lying sandstone? Unfortunately, there is little to guide us in estimating the speed at which a meteorite reaches the earth, or its power of penetration. Many meteorites (Peary's giant Cape York iron, weighing $37\frac{1}{2}$ tons, the Williamite iron, and the Bacubirito iron) have been found penetrating the surface only a comparatively short distance. The greatest depth of penetration of a meteoric stone which has come under Mr. Merrill's observation is that of Knyahinya, Hungary, as described by Haidinger. In this instance a 660-pound stone, striking the ground at an angle of some 27° from the vertical, penetrated to a depth of eleven feet. The hole was nearly circular in outline, and fragments from the interior were thrown back and scattered to a distance of some 180 feet. The stone was found broken in three pieces, and the earth beneath it compacted to stony hardness, but nothing in the description as given indicates that any traces of metamorphism, either in the ground or mass of the stone, had taken place. On the other hand, still heavier masses have been found under such conditions as to lead one to infer they scarcely buried themselves.

The subject, therefore, is full of difficulties; and we cannot do better than quote Mr. Merrill's hypothesis, which is as follows:—Let one conceive of a spheroidal mass of meteoric iron, perhaps 500 feet in diameter, falling upon the earth at a speed of 5 miles per second. The superficial rocks are crushed and thrown back upon the plain in an amount more than equal to the bulk of the meteorite. Mr. Tilghman, an authority on impact of projectiles from heavy ordnance, has estimated that in rocks as brittle as those of this particular vicinity the crater formed would be eight to ten times the diameter of the projectile; that is, with a 500-foot projectile the crater might be 4,000 feet in diameter, which is approximately that of the existing crater. As depths below the surface increased, the upward escape of material around the mass would be impeded, and that directly in its path and, to a less extent, that on either side would become enormously compacted. The heat generated by the sudden downward plunge of the body would produce fusion and probably a partial volatilisation, and where sufficient moisture was present, other conditions being favourable, would give rise to the pumiceous structure found in the altered sandstone. But certain after-effects must be taken into consideration. That there was moisture is evident by the existence of the pumice. The effect of the impact would be to convert almost instantly this moisture into steam with an enormous explosive power. As a result, quantities—the amount being dependent upon the amount of water—of *débris*, including even portions of the meteoric fall itself, would be ejected and thrown back above the crater rim and scattered widely over the plain. It would seemingly be safe to assume a temporary pseudovolcanic condition.

It is possible that the estimated size of the body making the crater is an exaggeration, since if, as seems probable, volatilisation of a considerable portion followed immediately upon striking the ground, the outrush of vapour due to the enormous expansion in passing from the solid to the gaseous condition would certainly have served to tear away the rock and increase the diameter to an extent that we have no means of estimating.

[*The illustrations appearing in this article are reproduced from the Smithsonian Miscellaneous Collections.*]

CORRESPONDENCE.

The Fourth Dimension

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—In the following note an attempt is made to put forward a mathematical proof of the real existence of, not only a fourth, but an infinity of dimensions, from a consideration of the form of infinite space.

That infinite length exists is obvious; taking for granted, with the majority of mathematicians, that a straight line is to be regarded as part of the circumference of a circle of infinite radius, it follows that infinite length is in the form of the circumference of a circle of infinite radius, *i.e.*, the boundary of a perfectly symmetrical infinite figure of two dimensions, but the existence of the boundary of a figure implies the existence of the figure itself, consequently infinite surface exists.

The form of infinite surface must of necessity be that of the surface of a sphere of infinite radius, for each infinite line in the surface is the circumference of a circle of infinite radius, *i.e.*, the form of infinite surface is the boundary of a perfectly symmetrical infinite figure of three dimensions, consequently infinite space exists.

Now, by the continuity of mathematical law, infinite space must be in the form of the boundary of a perfectly symmetrical infinite figure of four dimensions, but, as pointed out above, the existence of the boundary of a figure implies the existence of the figure itself, consequently the fourth dimension exists and it is infinite.

This, then, by a similar argument, leads to an infinite fifth dimension, and so on *ad infinitum*.

Yours, etc.,
H. STANLEY REDGROVE, B.Sc.

The Polytechnic,
Regent St., W.

Portable Sundials.

To the Editors of "KNOWLEDGE AND SCIENTIFIC NEWS."

SIRS,—The form of portable sundial mentioned by Mr. Parr in your issue for May as used in the Pyrenees is at least some centuries old, as may be seen in Holbein's picture of "The Ambassadors" in the National Gallery, where this form of sundial is depicted.

Yours, etc.,
AGNES FRY.

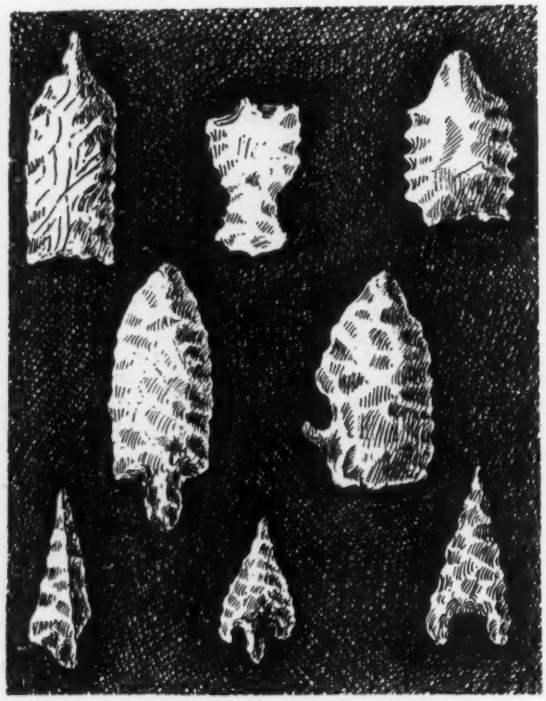
XUM

The Changos.
A Chilian Reminiscence.

By OSWALD H. EVANS, F.G.S.

STEAMING northward from Valparaiso, along the shores of Chile, the traveller day by day watches the sun-baked coast grow barer and more arid, the scanty vegetation grow scantier till it ends in a solitary clump of sombre dark-leaved trees in the valley plain of Caldera.

If he chances to be an artist striving to transfer to his sketch-book the dazzling contrast of sea and desert, the green of vegetable life here finally abandons his palette, leaving sienna, ochre and umber in all but undisputed possession. A strange land, seen over the steamer railing, stretching away in endless perspective north and south, the nearer mountain line as clear cut and hard in outline as stage scenery, with exquisite glimpses of distant giants softened to pale sapphire clouds by their remoteness through breaks in the chain.



Arrow-heads of unusual form, all found in the Taltal district.

Here the sea, well meriting its Pacific title, heaves shoreward in wide-reaching mounds of blue-black water to break in endless lines of silver foam at the foot of the gleaming mountain barrier. It is the edge of the South American Continent, the meeting place of a vast land with a vaster ocean.

Betwixt ship and shore long lines of ungainly pelicans string past on slowly flapping wings. Far off, where flurries on the oily water mark the skurrying fish shoals, glint and gleam the wings of white sea-birds, soaring and screaming, now dropping like stones through the air to vanish in a splash, now rising to fly heavily shoreward laden with their prey. Startled by the shadow of the vessel, a large cuttle-fish dives with a swirl of trailing tentacles, or a sea-lion stares with soft dog-like eyes at the intruder on his noontide slumbers.

So through the long still days and nights wonderful with stars the steamer passes between the little ports where ships sway slumberously at anchor before dusty rows of brightly-painted wooden houses, seeming all asleep in the baking sun. Some of these little places bear names still writ large upon maps of the country, but from them their minor glory has long departed. For the time being copper has given place to nitrate, and names once familiar in the market places of Europe now honour a few tumble-down huts, lost amid the surrounding desolation. The tide of commerce now sets to the northward, where, in the heart of the Atacama desert huge communities of men drawn from all nations win nitrate of soda from the burning Pampa, and the flags of all Europe make gay the crowded anchorages.

On these sun-scorched shores, between the desert mountains and the surf line, dwelt in the old time a humble race of savages, of whom the very name has now all but faded out of memory, and who have gone the way of the barbarian wherever he comes in contact with the white.

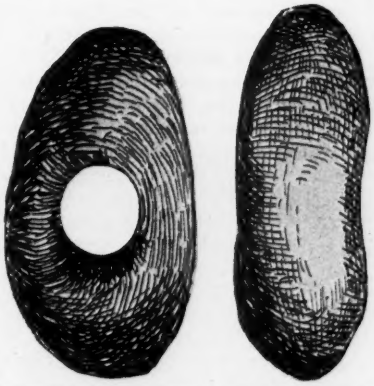
South America, no less than the Northern continent, is full of these fading memories of vanished peoples, long since departed into the mists of the past, leaving only some shadowy memorial in a few place-names of which the former meaning is lost, or more tangible relics in their graves. Such a race were the Changos of Chile and Peru, and such the fate that has overtaken them, a humble people, Esquimaux of the torrid zone, who struggled for a scant existence through long centuries on the shore of the Western ocean.

Wherever on the desert coast-line the mountain wall retires some little distance from the sea to leave a narrow fringing bay of terraced beaches "upheaven from the abyss," traces of the earlier people may be found in more or less abundance. On every headland jutting out to sea the boulder-strewn mounds mark their desolate graves, and wide-scattered *débris* of shell and stone indicate the site where once their flimsy huts were congregated.

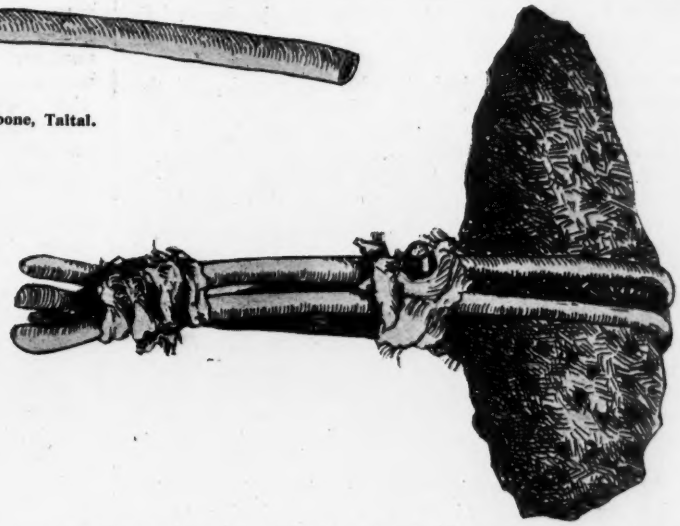
During two long years the writer chanced to spend his life on this lonely coast, surrounded on every hand by vestiges of the departed Indian folk. Through wandering over miles of relic-strewn beach, excavating among the burial places, and diligently collecting at every available opportunity, the simple story of their daily life and habits gained in clearness, and it became possible to present some sort of portrait of the tribe, even if only in silhouette.

In the first place then, these Changos were essentially a coast people, and of necessity fishers rather than hunters. Not that the interior desert was wholly uninhabited; there is good evidence to show that in the past the climate was somewhat more humid than at the present day, and where there is drinkable water, man can, and does, exist. It is probable that the present aridity of the soil was not so pronounced a feature, and that edible vegetation may have been fairly abundant at certain seasons of the year. However this may have been, we know that the coast tribes occasionally wandered into the interior, probably in search of suitable stone for the manufacture of their implements; we know also that the Incas of Peru

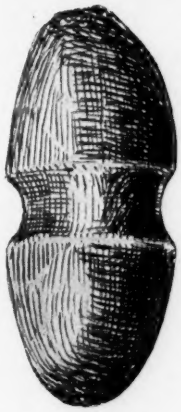
Implement of bird bone, Taltal.



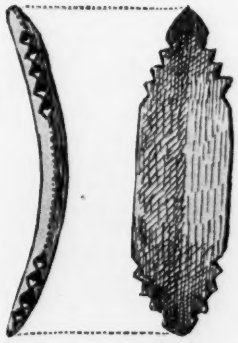
Perforated hammer stone, or weight of "digging stick," found on the coast near Valparaiso.



Stone "sledge hammer" found near Antofagasta. The handle is bound on with strips of llama hide, the hair still adhering. The figure is considerably reduced.

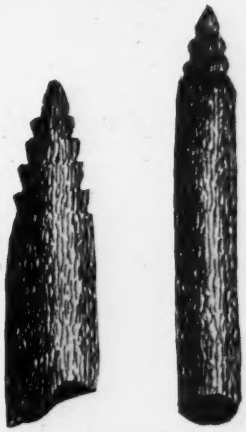


Grooved hammer-stone, Taltal.



Bone object of unknown use, found in a grave on Playa Hueso, Taltal. Traces of red colouring matter still remain.

Portions of bone fish-hooks.



Implements of schist, Taltal.

ARROW AND LANCE HEADS.

Harpoon head of bone.

Stone "borer" or "piercer," Taltal.

Taltal.

Antofagasta.

Pisagua.

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imposed a tribute of wood and water on the desert folk to supply the "tambos" or rest-houses marking the stages on the military road from Cuzco to Copiapó.

Dealing more particularly with the remains of the Changos found on the coast, we find them to consist chiefly of implements of stone and bone, human remains, pottery and fragments of personal ornaments.

It may be said that in many localities scarcely a square yard of surface could be found that would not reveal to careful search some evidence of pre-Spanish-Indian activity. Most common are the chips and flakes of the beautiful chalcedonic stone, from which the arrow and lance-heads were fashioned. This material, derived from cavities in certain volcanic rocks of the neighbourhood, is remarkable for its great beauty and extraordinary variety of colour. A series of specimens, ranging from a pure glass-like translucency through opaque white, grey, yellow, red, brown and purple to jet black might be gathered in a couple of hours.

The skill of the workman was worthy of the material. Nothing could exceed the gem-like perfection of the finest arrow-heads, which are covered with minute chipping, and frequently have their edges delicately crenulated. The same perfection of form and workmanship was lavished on the better examples of lance-heads. In shape and general appearance, this class of implement is almost identical with similar productions drawn from both Continents of America, whether compared with those of British Columbian tribes or with the bottle-glass arrow points fashioned to-day by the Yaghans of Tierra del Fuego.

Some of the most beautifully-worked specimens are so minute as to raise a question upon their possible utility. The same difficulty occurs in this connection all over the world. Various explanations have been advanced from time to time by different writers. There is a tradition current in Chile that they were poisoned. It has been suggested that they may have been of ornamental or ceremonial use; that they were children's toys, or used for killing small game; or again, that they served the purpose of lancets in primitive surgery. It is well-known that the coast tribes of Peru delighted in rash operations such as skull trephining, usually with lamentable results to the unfortunate patient. Among so many hypotheses the reader may take his choice, the writer inclines to the opinion that these tiny weapons were made use of in the same manner as the larger ones, a view strengthened by the observation that the puzzling specimens are found, often in a broken state, among others of normal shape and size.

Closely allied to the lance-heads are the harpoons of stone or bone. Most frequently these implements are ground into a long cigar-shape, from slate or schist, and usually have grooves chipped out near the point to serve as barbs. When made of bone, they strikingly resemble similar articles in use among the Esquimaux. Sometimes very little ones are found, which may have served to spear sea-urchins, then, as now, a favourite Chilian delicacy. The Chilian boys to-day spike them among the rocks at low water, using a piece of barbed telegraph wire, and eat the strange looking dainty raw, with evident relish.

That the prehistoric people were familiar with line fishing, numerous remains of their hooks bear witness. These hooks were made of two separate pieces of bone, a straight shank and a curved barb, bound together at the junction with animal sinew. Great numbers of hooks, arrow-heads, hammer stones, and bone-scoops were buried with the dead, in accordance with a widely-diffused savage custom.

Shell-fish formed the chief article of food, and more especially a large limpet-like mollusc, the *Concholepas peruviana*, which studs the rocks with its graceful shell everywhere between tide limits. That this was so is clearly shown by the enormous accumulation of shells always found around the Indian settlements, many of them in a fragmentary state. Scattered among the fragments lie scores of "hammer-stones," mere oval diorite pebbles from the nearest boulder beach, the abraided ends testifying to long continued use. The corresponding "anvils" are almost equally common, smooth, flat slabs, much chipped about the centres.

Animal food was not wholly lacking. Even at the present day, spring, with its short-lived luxuriance of herbs and flowers tempts the timid guanaco, the wild llama, from its haunt in the higher Cordillera to within sight of the railway. Ranging in far more numerous herds than now, this beautiful animal must have often fallen to the jasper arrow of the Chango hunter, who made ponchos of the golden fleece, and implements from the bones, besides varying his eternal fish diet with the flesh.

Sea-lions, more shy than of yore, still fight and roar on the surf-beaten reefs, and the sea-otter, now rarely seen, must have been a common quarry. Innumerable birds, pelicans, divers and gulls fill the air with clamour; at some seasons of the year, when the sardine shoals arrive, whitening the surface of land and sea with their incredible multitudes.

The Changos were nomadic, a habit enforced upon them by the nature of their food supply. A very short time suffices to exhaust the supply of shell-fish for the time being in any given locality, and thus the continuity of the Indian remains along hundreds of miles of coast-line is readily accounted for. More permanent settlements appear to have clustered round the scarce springs of brackish water which here and there, at the bottom of otherwise barren valleys, nourish a scanty vegetation.

(To be continued.)

MESSRS. CASSELL AND CO. are now issuing the "Nature Book" in fortnightly parts, price 7d. per number. The articles which appear in the first four parts to hand are well written in simple language, and admirably illustrated, and should appeal to all lovers of natural history. The ordinary holiday-maker who is at all interested in birds and their natural surroundings, and who intends to follow up the study during the present season, will find plenty of material in this work. Dr. W. J. S. Lockyer has an article on clouds, and a large range of other interesting subjects are dealt with, and illustrated by eminent writers.

LEITZ PRISM BINOCULARS.—Messrs. Ernst Leitz, of Wetzlar and London, call our attention to their new prism binocular of x6 magnification. Beyond improvements in the mechanical parts, they have introduced in the construction of the body of the glass a metal of an extremely non-porous character, thereby preventing dust or moisture from entering and depositing itself on the prisms and inside of the lenses with a consequent loss of clearness. By the use of this material they are not only able to save weight but to increase the rigidity of the glass. The one magnifying six times has an exceptionally large field of view, weighs but 12 ounces, and is sold at £5, in case with straps.

Some Novel Methods in Spectrum Analysis.

Photography of the Spectrum.

By W. MARSHALL WATTS, D.Sc.

SINCE the invention of spectrum analysis by Bunsen and Kirchhoff, in 1860, very great advance has been made, and the method has proved itself one of the most powerful weapons for the attack of problems in astronomy and molecular physics. But it is somewhat remarkable that as offering a simple method of ordinary chemical analysis, the spectroscope has not come into the universal use one would have expected, and in many laboratories the spectroscope seems almost unknown. There is now no reason why a spectroscopic outfit should not be found in every laboratory, and be made constant use of as a rapid means of identifying the constituents of a substance; and the photography of the spectrum is now so simple a process that it is easy to obtain permanent records of any analysis made.

One object of the present article is to enlist the interest of amateur photographers in the investigation of many problems waiting solution by explaining how easily any camera may be employed as a spectrograph, and how fascinating a pursuit the photography of the spectrum becomes. The transparent gratings in celluloid, first made by Mr. Thorp, which are replicas of the magnificent Rowland metal gratings of 14438 lines to the inch, are found to perform nearly as well as the original gratings,* and it is only necessary to place such a grating, mounted on plane glass, in front of the lens of any camera, to have at once a useful spectroscope or spectrograph.

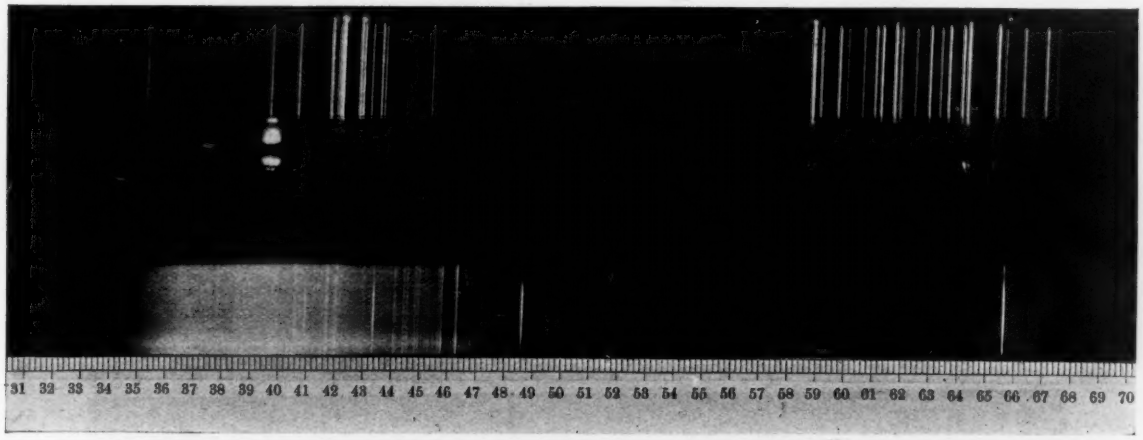

Fig. 1.

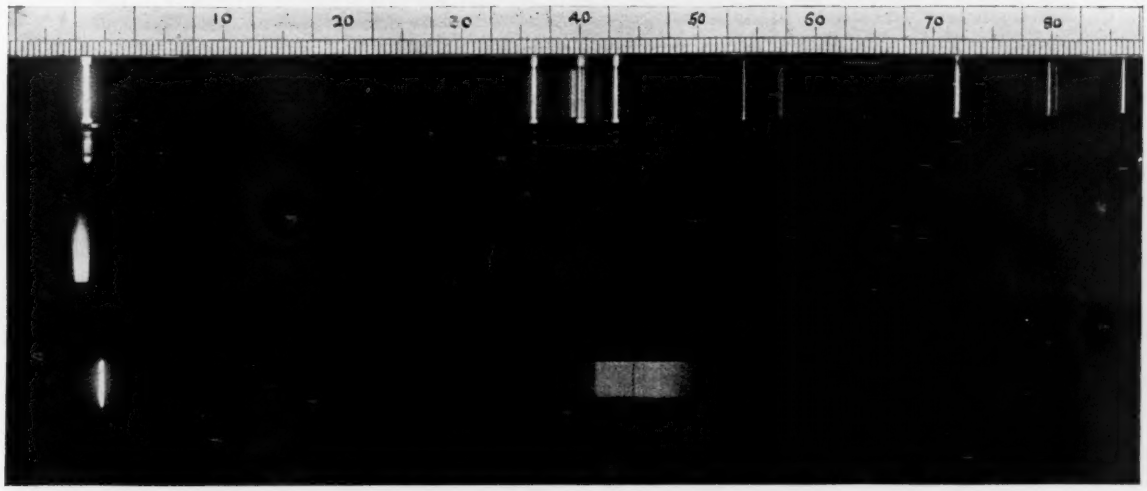

Fig. 2a

Fig. 2b.

With a lens of 15 or 20 inches focus, the whole spectrum is easily contained on a quarter-plate. Fig. 1 is an enlargement of the spectra of two vacuum tubes, the upper one containing neon and argon, and the lower one hydrogen, taken with a lens of 15 inches focal length; the original negative is about 2½ inches long. But, of course, the ordinary quarter-plate camera usually has a lens of about 5½ inches focal length, and with such a lens we can obtain upon the same plate both the image of the luminous object itself and its spectrum. Fig. 2A shows such a photograph

* See in the *Astrophysical Journal*, xxii., p. 128 (1905), a photograph of the solar spectrum taken with one of these gratings compared with the photograph obtained from the original grating.

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of a mercury vacuum-tube, heated by a Bunsen flame placed beneath the tube, taken by means of a Lancaster quarter-plate camera. The image of the tube itself is seen at the left, the first order spectrum occupies, roughly, the centre of the photograph, with the blue at the left, and the red at the right, and the blue of the second order is seen at the extreme right, with the group of blue mercury lines twice as widely spaced as in the first-order-spectrum. To have the correct exposure for the first order, the image of the tube itself is necessarily over-exposed, and the second order spectrum necessarily under-exposed.

Fig. 2B, shows the solar spectrum taken with the same camera; in the original negative the distance from the direct image of the slit to the H and K lines in the blue of the first order is an inch and a quarter, and the length of the spectrum from violet to red is about three-quarters of an inch.

One great advantage possessed by photographs obtained by means of gratings as compared with those given by prisms, is that the lines are spaced strictly according to wave-lengths, so that it is only necessary to apply a suitable scale of equal parts to the photograph to be able to read off at once the wave-length of any line, and with these small spectrograms the scale may be adjusted by means of the image of the object itself.

These plates are nearly as sensitive to red and yellow as to blue light, as is seen from the photograph of the red lines in the spectrum of neon (Fig. 1), obtained on a panchromatic plate. These plates must, of course, be handled and developed in total darkness, but the operation is quite easy. The plates being packed in pairs, face to face, they can be placed in the dark slide by feeling, even in total darkness. After exposure the plate is developed in the solution given below* for exactly three minutes, and then washed and fixed. All these operations are easily carried out in the dark.

It is hardly necessary to employ any screen with these plates, but if desired, a light yellow screen may be interposed for $\frac{1}{2}$ or $\frac{1}{4}$ of the whole time of exposure and then removed. The photographs thus obtained extend from the red to a point in the violet considerably beyond the visible spectrum, thus, in Fig. 1, the eye cannot distinguish the lines beyond about 4200.

If prisms are employed instead of gratings, the lines are no longer spaced according to wave-lengths, but are crowded together in the red, and spread out in the green and blue. Fig. 3 is a prismatic photograph of an electric discharge between magnesium electrodes *in vacuo* and superposed upon it the spectrum of iron for the purpose of furnishing reference lines.

The photographs of diffraction spectra shown in this article, and those which appeared in the numbers of

Photo by E. E. Brooks B.Sc. Mg. b. triplet. Mg. triplet near L.

Fig. 3.—Prismatic Spectrum of Iron and Magnesium.

this journal for May and June, are all taken without the usual slit and collimating lens, and for the purposes we have in view there appear to be advantages in this unusual procedure, viz.: in greatly lessening the time of exposure, and in obtaining the spectra of different portions of the source of light on the same plate. In the photograph of the neon spectrum peculiarities are recorded which might have escaped notice if a slit and collimator had been employed, *e.g.*, the remarkable luminosity of the negative bulb at 3948. This is not a neon line, but is the argon line, 3948.5, although the tube was supplied as being a Neon tube.

In the photographs of the flame-spectra of barium, strontium, and calcium, p. 127, the differences in character between the sharp line of sodium and the broad bands due to the oxide or chloride of the substances are strongly marked; the width of the bands certainly varies with the quantity of substance present in the flame, and they are seen to thin out upwards as the density of the volatilised salt becomes less.

Amongst useful work to be done with the inexpensive equipment described, may be mentioned the photography of lightning and of meteors. If the camera with its grating is exposed on a dark night during a thunderstorm, we may be fortunate enough to obtain not only the record of the lightning flash itself, but also of its spectrum, consisting of a number of traces parallel to the flash, one for each line of the lightning spectrum;* and the wave-lengths of these may be read off at once on a scale adjusted by means of the image of the flash itself.

The ordinary gelatino-bromide plate is sensitive only to about wave-length 5000, *i.e.*, only the blue-green; and as the usual glass lenses absorb light more refrangible than about 3500, spectroscopic investigations by means of photography are often confined to this limited region.

To photograph the red, orange, yellow, and the greater part of the green, it has been necessary to employ specially-sensitised plates, requiring very long exposure. The introduction of new plates sensitive to red and green, and in particular, the "Panchromatic" plates of Messrs. Wratten and Wainwright, have made it easy to photograph the whole of the visible spectrum.

* Such a photograph of a lightning flash and its spectrum is shown by Dr. W. J. S. Lockyer in the Science Section of the Franco-British Exhibition. The attention of readers of this article may be directed also to the diffraction gratings exhibited by Mr. Thorp.

* Equal parts of solutions A and B:—

Solution A.—	Hydroquinone	140 grains
	Metol	20 ,,
	Sodium sulphite ..	2 ounces
	Water to make	20 ounces.
Solution B.—	Potassium carbonate ..	2 ounces
	Sodium carbonate ..	2 ,,
	Water to make	20 ounces.

Photography: Pure and Applied.

By CHAPMAN JONES, F.I.C., F.C.S., &c.

Mercury in the Air. Metallic mercury has long been known to be volatile at ordinary temperatures, and the story of Daguerre's discovery that its vapour was the active agent that had developed the image on the exposed plate that he had been disappointed with, is generally familiar. It has been found that metallic mercury cooled to the freezing point of water still gives off enough vapour to develop a daguerrotype, and Faraday found that gold-leaf was whitened by exposing it over a vessel of mercury for two months even in cold weather. But the estimation of the actual quantity of mercury that exists in the air in the vicinity of the metal or certain of its compounds, has not, so far as I know, been undertaken until M. P. Ménière recently worked out a method for doing so, primarily for therapeutic purposes. He draws the air successively through two flasks containing boiling nitric acid, taking care to thoroughly condense and return to the flasks the vapours given off from the boiling liquid by means of cooled spiral tubes. By this means the mercury-vapour in the air is retained by the acid and converted into nitrate. The acid is evaporated to a few drops, diluted with water, treated with a solution of diphenylcarbazide and the reddish or violet colour produced compared with a series of standard tints, unless there is sufficient mercury for estimation by other methods. Air that had been drawn over metallic mercury, amalgams, &c., at 12° C., contained about half a milligram of the metal in a cubic metre, while at the temperature of boiling water this was increased to about a thousand times as much. The air of a closed room in which was an open vessel of mercury, contained three milligrams per cubic metre after three days, and nine milligrams after nine days, the temperature being 15° C. Thus it is obvious that the presence of mercury, mercurial ointment (which may be on the person), or anything of the sort, is a factor that may have to be taken cognisance of in a photographic laboratory or dark-room, especially if the ventilation of it is deficient.

Reversal by Rontgen Rays. M. Chanoz (*Comptes Rendus*, CXLVI., 172) has obtained reversal and re-reversal of a gelatino-bromide plate by a graduated exposure to Röntgen rays, a result analogous to the effects of prolonged exposure to light in the classical experiments of Janssen. He placed a thin strip of steel (.12 mm. thick, and several millimetres wide) tempered to a blue colour, so as to partially cover a Lumiere blue label plate, and wrapped up the arrangement in black paper. It was then covered by a protective screen made of steel and thickly covered with lead, and placed ten centimetres distance from the anti-cathode of an excited X-ray tube. By withdrawing the lead-covered screen as required, a series of graduated exposures was given to the plate. The result on development showed that at first, up to about two minutes' exposure, the image of the thin steel strip is negative as usual. With more exposure there was no difference on development between that part of the plate covered by the steel and the part that received the full action of the X-rays. A ten minutes' exposure gave total reversal—a positive image, and after this came a second neutral stage. The longest exposure given of one and a half to two hours, yielded a second negative image. Density measurements of the plate would have been interesting, but the author does not give them. But it is quite clear that he found an exposure of about five times normal to give reversal, and sixty times normal to give re-reversal—figures which are very small indeed, compared with the increased exposure generally necessary to get reversal effects by light. It must, however, be remembered that silver bromide in gelatine does give reversal with exposures of approximately the same order as those found by the author for X-Rays, and that one reason for adding iodide in ordinary plates is its powerful effect in restraining reversal. Perhaps one may venture to suggest that the X-rays may change the silver bromide into the developable condition as if the iodide were not present, while the action of light itself, is, as we know, modified by the presence of the iodide. There are several other points connected with this interesting experiment that we should like to see investigated. The re-reversal is specially noteworthy, as it has not always been obtained by those that have sought for it.

Colour Photography. The second annual exhibition of the Society of Colour Photographers, which has just closed, did not reveal anything particularly new. Two or three exhibitors demonstrated that the three-colour process, using pigmented tissues, will, when the worker is sufficiently skilful, yield excellent results; other exhibitors showed how easy it is to fail. The great majority of the autochrome transparencies appeared to be neither better nor worse than those that we have become accustomed to, but a few very excellent ones without the garish colours that so many seem to consider desirable, and with no predominating tint, showed what this method is capable of at its best. The granularity due to the imperfect mixing of the differently coloured starch grains is still often visible. The usefulness of these plates in the photo-micrography of stained preparations was demonstrated by Drs. Rosenheim and Hurry, and Mr. Welborne Piper showed that it is possible to reproduce an autochrome on another autochrome plate, or to use a negative autochrome (which shows the complementary colours, and is made by omitting the reversing operation), for the preparation of other autochromes, exposing either by superposition or in the camera. Messrs. Sanger-Shepherd and Co., showed some excellent transparencies by their well-known process, and also a series illustrating their new imbibition method. In this case a transparency is toned blue as usual, but the yellow and pink constituents of the compound image, instead of being superposed as separate films, are added by absorption of the dye into the one film by contact with a dyed gelatine relief. There was no evidence of the newer screen-plate processes that are to compete with autochrome plates, but as this exhibition was held only about six months after the previous one, evidence of much progress is hardly to be expected.

Received. An illustrated pamphlet from the London Stereoscopic and Photographic Company, describing their "Artist" reflex camera, and showing its usefulness to naturalists, as well as for portraiture, telephoto., high speed, and other work.

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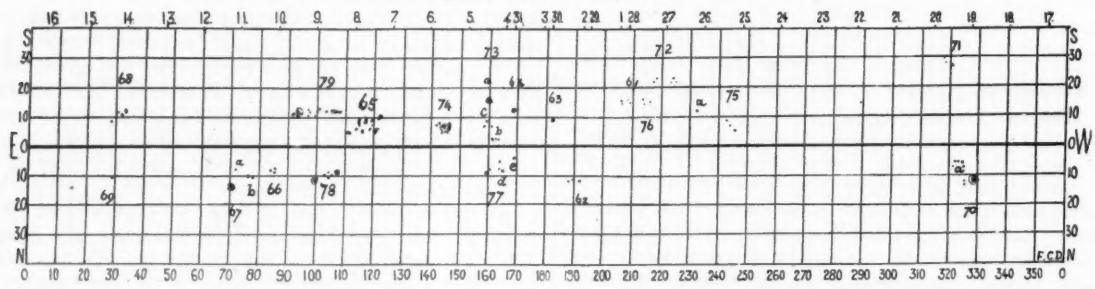
Solar Disturbances During May, 1908.



THE chart gives an epitome of the observations of Messrs. J. McHarg, A. A. Buss, and F. C. Dennett, and drawings by Mr. A. Mee. The longitude of the central meridian at May 1 was 205° 27′, considerable activity being maintained.

Nos. 61, 62, 63, 64, 64*a*, and 64*b* are the legacy left from April.

No. 64*c*.—A little outbreak, 15,000 miles long, between 64*a* and 64*b*: 8th to 11th.

No. 64*d*.—A pore on N. side of equator, only seen 1st.

No. 64*e*.—A similar pore, seen 7th-9th.

No. 65.—Two pores 7th-9th, with a larger companion 10th. The number and size of its components, as likewise its area, increased considerably until it was 82,000 miles in length. 7th-13th.

No. 66.—A solitary pore 6th. Three 7th.

No. 67.—A spot, 18,000 miles across, and pore, afterwards breaking up into a group of pores, and dying out. 6th-13th.

No. 67*a*.—A pore 22,000 miles nearer the equator, in a disturbed area. 7th-9th.

No. 67*b*.—A pair of considerable spotlets 11,000 miles apart, only seen 12th.

No. 68.—Two pores nearly in the same meridian, 22,000 miles apart, in a faculic area on 9th, the northern seemed to drop behind, 11th and 12th four members, 37,000 miles long; two pores 13th, and one 16th-19th.

No. 69.—A pore seen only 12th.

No. 70.—A spot 20.000 miles in diameter, the umbra sometimes bridged. Pores north-east 15th-17th, and one north 18th-20th. 13th-25th.

No. 70*a*.—Pores showed on 17th, which by noon 18th formed an elliptical group undergoing much transformation till last seen as a pore in bright faculæ on 24th.

No. 71.—A group of three pores, only seen on 22nd.

No. 72.—On 25th three minute pores seen, which by 27th formed a little triangle and a pair, when at its maximum, but it was not seen after.

No. 73.—A solitary spot, 12,000 miles in diameter, decreasing; a return visit of No. 64*a*. May 26 to June 6.

No. 74.—A fine spot 30,000 miles by 24,000 miles in area, with umbra finely bridged. Tiny pores near 28th-29th, and June 2-5. May 27-June 8.

No. 75.—A line of three pores 28th, and a small triangle 29th.

No. 75*a*.—A pore 28th-29th.

No. 76.—Pores on the site of the western part of No. 61. 27th-28th.

No. 77.—A brilliant faculic ring seen 27th, with three spotlets increasing on 28th; a spotlet enlarging to 7000 miles, the pores 31st 45,000 miles long, a pore only 2nd. Closely north of place of No. 64*d*.

No. 78.—A group of spots 74,000 miles long. The largest spot, 15,000 miles in diameter, decreasing after June 5th. May 30-June 9.

No. 79.—A larger group, on June 3rd, the leading spot 23,000 miles long, and the final penumbral spot 29,000 miles in diameter.

On 7th several tiny spotlets about longitude 130°, but in latitude 60° or 70° North.

On 23rd, a pore seen in south latitude about longitude 180°.

On 30th, a pore was noted between Nos. 73 and 74.

In these three cases no measures were made.

NOTES.

ASTRONOMY.

By CHARLES P. BUTLER, A.R.C.Sc. (Lond.), F.R.P.S.

A Remarkable Solar Storm.

SOME magnificent spectroheliograms of the solar surface recently sent over by Professor G. E. Hale, are of special

Fig. 1.—Solar Storm photographed in "Hα" light, with the Spetrohelioograph at Mount Wilson, California, 1908, April 30th, 5h. 06m. p.m., by G. E. Hale.

interest in that a most remarkable solar storm is depicted on the plate obtained at Mount Wilson on April 30, 1908.

We hope to do this better justice in a subsequent illustration on a larger scale, but the accompanying photograph will give an idea of its nature. The series of plates, of which this is one, have been taken in the red hydrogen line H α, using pan-iso plates, prepared according to the orthrochromatic bathing formula of Wallace, and it appears quite certain that new features of the configuration of the solar envelopes are being thus brought to view, as we know that H α behaves differently in many respects from the other hydrogen lines. The disturbed area extends over about

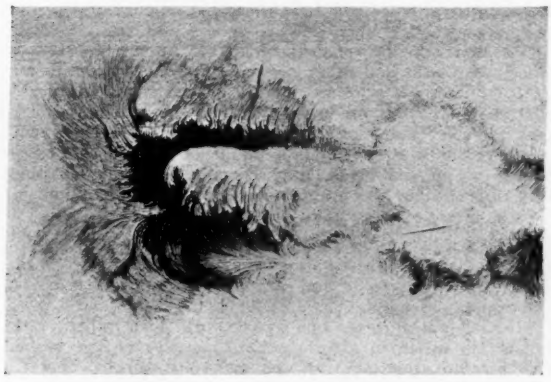


Fig. 2.—Drawing of a typical Sunspot by S. P. Langley, Allegheny, 1873.

one-quarter the diameter of the sun in its longest dimension, and careful examination will reveal the existence of numerous distinct solar whirls or vortices, often with dark markings like spots as centres. This gives the appearance as if the hydrogen medium were being sucked down (or belched upwards) from all directions. It is perhaps also interesting to recall in comparison the historic drawing made by Young in 1873, in which he delineates the structure of a typical sun-spot. The similarity of the vortex streams in this drawing and in Hale's spectroheliogram is very striking, and it would appear that we are on the eve of demonstration of fundamental facts of solar structure.

Photographic Determination of Star Colours.

Messrs. J. A. Parkhurst and F. C. Jordan describe their preliminary investigation of the possibility of determining star colours photographically. It has been recognised for some time that eye estimates are unsatisfactory, and the method suggested by Schwarzschild appeared to offer sufficient reason for a practical trial. This was, that the difference between the visual magnitude and the photographic magnitude as measured on ordinary plates (sensitive only to blue and violet radiation), would give a satisfactory measure of the colour of the star. The authors have extended this by determining the *visual* magnitudes by plates sensitive to green and red rays, thus bringing both processes out of the personal type. Pairs of ordinary and isochromatic plates were exposed regularly from 1904 to 1906 with the 24-inch reflector of the Yerkes Observatory. Later a special filter was used with the isochromatic plates, which gave the visual magnitudes direct without any correction being required. The respective magnitudes on the two kinds of plates are obtained by measuring the diameters of the star discs. Numerous colour pairs have been taken on Seed plates, and Wallace's pan-iso plates, and it is proved that by this method it is possible to obtain correct visual magnitudes of coloured stars of different tints.

An interesting extension of the research is the relation of colour-intensities, as above determined, to spectral class. A series of spectra were photographed with an objective prism by Zeiss, of 145 mm. aperture and 15° angle, fitted to a doublet lens of same aperture, and 814 mm. focal length, giving a dispersion of 2.7 mm. between F and K. In spite of this small scale the definition is so good that the spectral type of stars brighter than magnitude 9 can be readily seen on plates of one-hour exposure. Taking the Draper Catalogue of stellar spectra, it is found that definite colour intensities correspond to definite spectral types. This will probably furnish a useful means of determining the spectral type of stars too faint for the ordinary spectroscopes. One hour's exposure with the reflector at 18 inches aperture will give measurable colours of stars to the fourteenth magnitude.—(*Astrophysical Journal*, Vol. 27, p. 169, April, 1908.)

The Tores of Saturn.

On June 19, 1907, an interesting new phenomenon disclosed itself in the Saturnian system in the form of a curious detail in the shadow which at that time banded the planet's equator. The band itself was dusky rather than dark, and presented, when first looked at, a triple appearance, which on more careful scrutiny proved to be due to a narrow black line that threaded it medially throughout its length. The sun at the moment was 32′ north of the plane of the ring system, and the earth 2° 16′ south of it. In November, 1907, the phenomenon was again observed. The mean of the measures gave 0″.46 for the whole shadow, and 0″.10 for the black core.

When the rings were again examined in November, agglomerations were plainly visible, symmetrically placed on either side of the ball, and continued observation showed them to be permanent in position. As their positions do not agree with the computed values on the theory that the rings are flat, it is supposed that rings B and C are *tores*, or of the shape of anchor rings, with a curved cross-section. These viewed edgewise, would make their presence seen by heapings up of light at two patches symmetrically placed on either side of the planet, at the ansae. From the width of the shadow it also appears that the rings cannot be flat. Professor Lowell suggests that the material particles of the ring are in partial collision, producing a certain disintegration in process, and shows that the portions of the tores agree with those predicted by analysis of the degree of commensurability of the orbits of Mimas and Enceladus.—(*Lowell Observatory Bulletin*, No. 32.)

Royal Observatory, Greenwich, Report for 1907.

The annual report of the Astronomer-Royal for 1907 was presented to the Board of Visitors to the Royal Observatory, Greenwich, on June 3, 1908, and deals with the work from May 11, 1907, to May 10, 1908.

Transit Circle.—At the close of October, 1906, a system of two close vertical wires and one horizontal wire was inserted in each collimator in place of the system of inclined wires formerly in use. The improved method of central illumination from the object glass has been fitted, and a series of comparisons with the old and new illuminations is being made, which it is hoped will throw light on the question of magnitude equation of faint stars. Regular observations of the sun, moon, planets, and fundamental stars were made during the year.

Altazimuth.—The new central illumination has proved very satisfactory. The instrument has been used as a reversible transit in the meridian in four positions during the year, and observations of the sun, moon, planets, and fundamental stars made throughout. The work on the lunar crater Mosting A has been continued, and in combination with similar work at the Cape will provide data for a determination of the lunar parallax.

Reflex Zenith Tube.—Eighty-five stars have been observed throughout the year, including β and γ Draconis and i^2 Cygni. A start has been made with the discussion of the observations since 1903, for the determination of the variation of latitude, but some difficulties have arisen on account of variation in the scale values.

28-inch Refractor.—This has been employed chiefly for the observation of double stars, measures being made on 105 nights. Equatorial and polar diameters of Jupiter were measured, and also the diameters of the satellites.

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Thompson Equatorial.—The 30-inch reflector on this mounting has been employed in the photography of the satellites of Saturn and Jupiter, comets, etc. The most interesting part of the report is that on one of these photographs, Mr. Melotte found the eighth satellite of Jupiter, which was ultimately measured on 11 plates.

The 26-inch refractor was employed for photographing Neptune and its satellite with a special occulting shutter. Thirty-one photographs were obtained on 16 nights.

Astrographic Equatorial.—Work with this is still confined to replacing chart plates which are unsuitable for reproduction; 177 photographs have been taken on 74 nights. The work of the Greenwich section of the Astrographic Catalogue is complete so far as the publication of the measured rectangular co-ordinates and the data necessary to convert them into Right Ascension and Declination is concerned.

Photoheliographs.—Photographs of the sun were taken with the Thompson instrument on 210 days, and with the Dallmeyer lens on 2 days. The year 1907 was remarkable in presenting more solar activity than 1906, though somewhat less than 1905.

Magnetic Observatory.—The various observations have been made as in former years, the chief values for 1907 being as follows:—

Mean Declination	=	15° 59′.8 west.
Mean Horizontal Force	=	4.0195 (in British units). 1.8533 (in metric units).
Mean Dip	=	66° 56′ 4″.

During the year there was only one day of great magnetic disturbance, and 16 of lesser disturbance.

Meteorology.—These observations were made as usual, and the summaries show that the mean temperature for the year was 49°.4, being 0°.2 below the average for the 65 years 1841-1905.

The mean daily air movement was 290 miles, which is 9 miles above the average of preceding 40 years, indicating an exceptionally windy year. Rainfall for the year was 23.14 inches. Bright sunshine 1,386 hours out of 4,472 hours during which the sun was above the horizon. An interesting collection of historical apparatus, and a representative series of photographs, meteorological apparatus, models, etc., have been sent to the Science Section of the Franco-British Exhibition to illustrate the work of the Observatory.

The danger which threatened the work of the Observatory from the County Council electric generating station, immediately on the meridian to the north, has been to some extent minimised by the agreement to work the engines at reduced power. There appears to be evidence, however, that the heated gases interfere with the meridian observations of north stars and a reduction of their height is recommended.

Encke's Comet.

The return of Encke's comet was observed by Mr. Woodgate, of the Cape Observatory, on May 27, 1908. A telegram from the Kiel Centralstelle states that the position at 17h. 49m. (Cape mean time) was RA = 2h. 59.3m.; Decl. = 7° 29′ S. As this is rather low down in Eridanus, the comet is not yet situated favourably for observation in Europe.

BOTANY.

By G. MASSEE.

Bacteria as Agents in the Oxidation of Amorphous Carbon.

PROFESSOR M. C. POTTER gives an interesting account in *Proc. Roy. Soc.*, of the action of bacteria on such substances as lamp-black, peat, and coal. When exposed to the air a slow oxidation takes place through the agency of bacteria. Carbonic acid is given off, the amount increasing in proportion to the rise in temperature, and ceasing to be evolved at a supra-vital temperature. Under perfectly dry conditions, such as preclude the possibility of bacterial life, there is no evolution of carbonic acid. A distinct rise of temperature occurs through the action of bacteria, whereas when carbonaceous substances are preserved from the intrusion of micro-organisms, no rise of temperature takes place, and carbonic acid is not evolved.

The heat generated by microbial activity must be taken into account in connection with the oxidation and spontaneous combustion of coal, and may prove to be a dangerous motive force acting upon explosive gases. The oxidising action of bacteria must be largely responsible for the disintegration of coal, and the great amount of depreciation it undergoes when stored.

Coal, one of the most insoluble of known substances, along with peat and other organic matter, become disintegrated by aerobic organisms when placed under favourable conditions, the carbon being liberated as carbonic acid to play its *rôle* once more in the life-cycle. It is thus conceivable that the enormous amount of carbon at present locked up in coal-fields, may become available for plant nutrition without the intervention of direct combustion.

The Water-Storing Tubers of Plants.

Dr. Harshberger gives an account in the *Bull. Tor. Bot. Club* of certain investigations on the tubers of two ferns, *Nephrolepis cordifolia* and *N. davallioides*, and those of *Asparagus sprengeri*.

Micro-chemical tests on sections of fresh tubers were applied in order to ascertain the character of the respective reserve materials. In the two fern tubers, there is an entire absence of starch and protein granules. On the other hand, the presence of sugar and tannin were clearly demonstrated, and it is considered that the tannin present becomes slowly transformed into sugar. These tubers vary in size from a pea to that of a pigeon's egg, and when dried in the sun lose their water and shrivel up to a small mass of dried material. The water content is about 96 per cent. of the whole weight. The author considers that the character of the reserve material stored in the tubers having been determined, it can be stated definitely that water-storage is their principal function. When tuber-bearing ferns are planted in dry soil the fronds remain green, Gradually, however, the water disappears from the tubers, which become shrunken.

In *Asparagus sprengeri* tubers, there is an absence of starch, protein granules, also of tannin and sugar, and the conclusion is that the tuberous roots are developed for the purpose of storing water, the necessity for which is determined by the epiphytic habitat, or growing in a comparatively arid region.

A New Myxogaster Endoparasitic in an Insect.

M. Leger describes in *Comptes Rendus* a myxogaster, the type of a new genus, named *Sporomyxa*, parasitic in the genital organs, fat bodies, and blood of *Scaurus tristis*, a beetle found in Algeria. *Sporomyxa scauri*, the new species, during its vegetative stage, is an ovoid or spherical body, about 8 μ diam., and containing one nucleus. The amoeboid bodies contain two to eight large spherical nuclei, each with a nucleolus and chromatin network. This is the first occurrence of an undoubted myxogaster endoparasitic in an animal.

Honey-Producing Algæ.

M. Miraude points out in *Soc. Biol. Paris* that on the borders of the Lez, in the neighbourhood of Montpellier, pools of water are covered with a filamentous alga belonging to the genus *Zygnema*, and at such places bees collect in numbers. It was found that when the water from these pools evaporates, and the algæ commence to decompose, a very considerable quantity of glucose is present in the mucilage. The glucose proved to be the substance that attracted the bees.

Plant Diseases in Norfolk Island.

Mr. J. H. Maiden, in describing the flora of Norfolk Island, has some notes on fungus pests attacking introduced cultivated plants. Potato disease, caused by *Phytophthora infestans* is very prevalent, and acts in a

similar manner as at home, the haulm withers right down in a day, and the tubers become spotted and rotten. Leaf-curl, due to *Exoascus deformans*, is present on peach trees Maize and onions are also attacked by their respective smuts.

The above parasites are common on the host-plants named above in their native countries, and have undoubtedly been imported along with the plants to Norfolk Island.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (Oxon.), F.I.C.

Prussic Acid in Feeding-Stuffs.

COMPOUNDS containing hydrocyanic acid (prussic acid), are of fairly common occurrence in other plants than cassava, reference to which was recently made in these columns ("KNOWLEDGE," 1907, p. 282). A list of no less than 135 of such plants was made in 1906 by Dr. Greshoff, and since then the number has been considerably increased. From a practical point of view, the most important of the cyanogenetic plants are *Phaseolus lunatus*, producing the so-called Java or Rangoon beans, and *Linum usitatissimum*, the common flax or linseed. In each of these the hydrocyanic acid is present in the form of a glucoside, and is accompanied by an enzyme, which has the power of decomposing the glucoside and liberating the acid. During the last few years there have been numerous cases of cattle poisoning in Europe caused by the use of *Phaseolus* beans, large quantities of which have been exported from Java. The proportion of hydrocyanic acid varies with the kind of bean, the dark-coloured varieties from Java and Mauritius yielding much more than the light-coloured beans from Burmah, while the large white beans grown in France and the United States are frequently quite free from the poison. It has been shown, however, by Messrs. Tatlock and Thomson, that white beans may yield a relatively large amount of hydrocyanic acid, and according to the experiments made by Messrs. Henry and Auld, it is not possible to draw any definite relationship between the colour and the proportion of acid. The enzyme accompanying the glucoside is destroyed by heat, and the beans then become non-poisonous, provided no other substance capable of liberating the acid is added to them.

The flax plant has been found to contain as much as 0.18 per cent. of combined hydrocyanic acid, capable of being liberated by its accompanying enzyme, when the crushed material is mixed with water. Linseed itself contains about 0.01 per cent. of the acid, and this becomes concentrated in the residual seed-cake resulting from the expression of linseed oil. Commercial samples of the linseed cake given as a feeding-stuff to cattle were examined by Messrs. Henry and Auld, and found to yield about 0.04 per cent. of hydrocyanic acid on treatment with a dilute mineral acid. Although a case of poisoning through cows eating young flax plants occurred in 1905, in India, no case has yet been reported of ill-effects resulting from the use of linseed cake as a feeding-stuff. The explanation of this is to be attributed to the fact that in the expression of the oil from the seeds, sufficient heat is employed to destroy the enzyme, and the hydrocyanic acid thus remains in the seed in the form of the inert glucoside. The seed-cake no longer gives off hydrocyanic acid when mixed with water, but still does so when an addition of crushed unheated seed is made to the mixture. In the opinion of Messrs. Henry and Auld, it is hardly safe to assume, in feeding cows with cyanogenetic feeding-stuffs in which the enzyme has been destroyed by heat, that other materials containing a similar enzyme may not be given at the same time, or that the glucosides are not capable of being decomposed by enzymes secreted in the intestine of the animal.

The Influence of Light on Fermentation.

Messrs. Purvis and Wilks have studied the effects of light rays of various wave-lengths upon alcoholic fermentation. The experiments were carried out in vessels of glass or of copper, having one side of ordinary glass, red glass, or a flat vessel containing copper sulphate solution. In the case of the glass vessels, the fermentation was not perceptibly affected by the different kinds of rays, but there was a considerable effect when a copper vessel was employed. Thus, blue light checked the development of bacteria in a marked degree, and more sugar was fermented in blue and in white light than in red light or in the dark. The copper itself weakened the activity of the yeast, especially in the case of liquids poor in sugar. Blue light had also some influence in preventing the rise of temperature, which, as a rule, rose to a higher degree when the fermentation took place in the dark or in red light.

GEOLOGY.

By EDWARD A. MARTIN, F.G.S.

Footprints in the Exeter District.

MR. A. W. CLAYDEN has described before the Geological Society of London some "Footprints in the Lower Sandstones of the Exeter District." Such footprints are very rare. Dr. Shapter has recorded "claw-like footmarks," etc., from a locality about half a mile north-east of Broadclyst, and in another quarry which has been recently reopened here for building-stone, slabs with footprints were found by the author and his students. Later, a slab with a track containing 30 pairs of footprints was found. In all five specimens have been secured for the Exeter Museum. Three of the sets of prints may have been made by the same individual, one with front and back feet about the same size, and bearing about the same weight, but the two other sets of prints were made by smaller and different individuals. There is no trace of the tail being dragged. In one case the track shows that the animal sometimes threw nearly all its weight on the right side and sometimes on the left. In no case is there anything to suggest either claws, a sole to the foot, or a fifth digit. They are not unlike Chierotheroid prints, but differ from them in the absence of a divergent digit.

The Basic Dyke of Bartestree.

The dyke at Bartestree, near Hereford, is a basic intrusion having a thickness of about 35 feet, and strikes in an east-north-easterly direction through the Old Red Marls and Sandstones. Professor S. H. Reynolds, M.A., F.G.S., states that for a distance of at least 10 feet from the contact these are strongly metamorphosed, the marl being converted into a hard purplish-grey rock with yellow patches, while in the sandstone the felspars are recrystallised, and the quartz-grains corroded. The extent of the metamorphosism is remarkable. The dyke itself is not a single uniform intrusion, but a multiple dyke composed of several allied but differing types of dolerite and basalt. While the major portion consists of basalt, the marginal portion is chiefly doleritic. The relations are clearly such as to point to the invasion of an earlier doleritic intrusion by a later one of basalt. It is suggested with some probability that the Bartestree dyke is of the same age as the Clee Hill intrusion.

Palæoliths.

I am indebted to Mr. H. S. Toms, Curator of the Brighton Museum, for some interesting remarks in regard to the implements which were figured in last month's issue. He contests the statement that they are to be regarded as palæoliths, and thinks that as they were surface finds, they cannot be ascribed to a precise period. He also states that similar implements have been found by himself and his friends in Sussex, including some of the barbed variety. He thinks that the hardest flint was not necessarily used for the purpose, at any rate in the case of those which he has seen. In regard to the boring of the holes in order to obtain the barbs, he remarks: "After the general contour of the arrow-head had been obtained by chipping with a hammer-stone, or a bone punch used in conjunction with the hammer, the notches between the barbs were produced

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by the comparatively easy method of "pressure flaking," the instrument used to detach the minute flakes, or chips, being either the bone punch or another piece of bone or horn. The common opinion as to the manufacture of ancient stone implements is that the prehistoric craftsmen 'devoted much time and labour to them.' One's own attempts in copying these gems of prehistoric art is that a beautifully chipped axe or arrow-head must have occupied but a few minutes of the ancient expert's time. In conclusion, may I point out that true palæolithic implements have been discovered in Sussex, the most important find being that made by Mr. R. Garraway Rice, F.S.A., in the old river gravels of the Rother. In my own collection there is also an undoubted tongue-shaped palæolith, found on the surface at Saddlescombe, near Brighton."

Scientific Congress at Hastings.

The Congress of the South-Eastern Union of Scientific Societies took place at Hastings last month. The President, Sir Archibald Geikie, F.R.S., gave the annual address upon the Geology of the South-East of England. Papers were read, amongst others of non-geological interest, upon the "Pleistocene Vertebrates of the South-East of England," by Mr. W. J. Lewis Abbott, F.G.S., and on "Some Considerations Concerning Dew-Ponds," by Mr. Edward A. Martin, F.G.S.

Women Geologists.

The recent poll of resident Fellows of the Geological Society resulted in a majority of 209 in favour of the admission of women to the Society, 342 being for, and 133 against it. Of the 342 in favour, 248 recorded their votes in favour of full Fellowship, and 84 against it, 10 not specifying which they desired. A poll will not be taken of Fellows non-resident in the United Kingdom.

METEOROLOGY.

By WILLIAM MARRIOTT, F.R.Met.Soc.

The Thunderstorm of June 4, 1908.

THUNDERSTORMS occurred over many parts of the country on May 30, and during the first few days of June. These were in many cases very severe, and were accompanied by heavy rain and large hailstones.

As the thunderstorm on the evening of June 4, at West Norwood, was of such an intense character, I think the following particulars about it may be of some interest.

The weather during the day had been very hot and close, the maximum temperature being as high as 84°.7. Thunder was heard in the afternoon from about 2.40 to 3.10. A fresh storm came on about half-past five, when distant thunder was heard. This storm gradually developed, and was most intense between 6.10 and 6.40. It continued till 7.30. After an interval of about a quarter of an hour, another storm came on at 7.44, and continued till 8.30.

As I arrived home soon after 5.30 I got the Brontometer to work, and so was able to obtain a record of the various features of the storm.

The Brontometer, which was devised by the late Mr. G. J. Symons, F.R.S., and was made for him by MM. Richard Frères, of Paris, in 1890, is an instrument for showing the sequence of the various phenomena occurring during thunderstorms. It is provided with endless paper, 12 inches wide, travelling under the various recording pens at the rate of 1.2 inch per minute, or 6 feet per hour. The atmospheric pressure is recorded by a modified form of Richard's statoscope, which is so delicate as to give 30 inches for each inch of mercurial barometer. There are mechanical arrangements whereby the observer records: (1) the commencement, variation in intensity, and termination of rain; (2) the instant of each flash of lightning; (3) the commencement and duration of each clap of thunder; and (4) the commencement, variation in intensity, and termination of hail.

Ninety-seven flashes of lightning were observed in 27 minutes, between 6.11 and 6.38. No records of lightning were taken from 6.38 to 6.44, owing to a fresh supply of ink being required to be put into the pen, but 63 flashes were observed between 6.44 and 7.30. Many of the flashes were of a brilliant character, and were mostly of the "flickering" or "repeating" type.

I recorded 123 peals of thunder between 6.10 and 7.30. There were probably considerably more, but it was most difficult to distinguish between the individual peals, as before one had ceased another or more would have been heard. The longest duration of the rumble of an individual peal of thunder was 70 seconds.

Rain fell from 6.7 to 6.32, and from 6.40 to 6.47. It was extremely heavy during most of this period.

Hail also fell from 6.13 to 6.33, the hailstones being larger than, and somewhat similar in shape to, big sized acid-drops. The intensity of the rain and hail may be gathered from the fact that 1.14 ins. fell in 33 minutes.

The barometer commenced rising at 5.58, and reached its highest point when the hail began. It then fell slightly from 6.49 to 7.4.

During the second storm 39 flashes of lightning were observed, and 39 peals of thunder were heard between 7.44 and 8.29. Rain commenced falling at 8.0, and continued till after 9 o'clock. The rainfall during this storm amounted to .15 in.

The Hong-Kong Typhoon, September 18, 1906.

At the meeting of the Royal Meteorological Society on June 17, a paper by Mr. Lawrence Gibbs was read, on the "Hong-Kong Typhoon of September 18, 1906." The typhoons of the China and Eastern seas usually have their origin in the Pacific to the eastward of the Phillippine Islands. They occur during every month of the year, but are of rare occurrence during the late winter and early spring. In view of the considerable area usually covered by a typhoon and their frequent occurrence during the season, there was nothing peculiar in the fact that one should pass close to Hong-Kong, but the fact which brought the typhoon of September 18, 1906, into such prominence was the failure of the Hong-Kong, Manila, and Zi-ka-wei Observatories to give adequate warning, and the consequent heavy damage to shipping and craft. This loss was accentuated by the fact that the typhoon centre passed to the north of the harbour, thus causing a north-westerly backing to southerly gale. The harbour is much less sheltered from the west than from any other quarter. Judged by anemometer records, the typhoon was by no means a severe one, as the highest average hourly wind velocity was 70 miles. In the harbour 45 merchant vessels were either badly injured, stranded, or foundered; 80 steam launches out of a total 256 were permanently or temporarily disabled, and a great number of lighters, junks, and small craft broken up. Sixteen Europeans lost their lives; 2,385 Chinese were reported missing, but as in many cases the whole family lived on the boat, and as many boats were lost with all hands, it is probable that this figure was considerably exceeded. The Observatory of Zi-ka-wei came more nearly than any other to an adequate forecast. The Hong-Kong Observatory did not consider the observations available on the 16th and 17th justified the issue of any typhoon warnings, but as at 8 a.m., on the 18th, it was found that the barometer was falling rapidly, and the weather appearing threatening, orders were given to hoist the Black Drum—the weather signal indicating that a typhoon was within 300 miles to the eastward of the colony—and at 8 a.m. the typhoon gun was fired, indicating that a strong gale of wind was expected to blow. This was only about an hour before the storm was at its worst. The author says that there is no doubt that it was the small area covered by this typhoon which caused the failure of the forecast.

Meteorological Calendar.

Messrs. George Philip and Son, Ltd., have just published a "Meteorological Calendar" (2s. net), for recording daily observations regarding the barometer, thermometer, rainfall, direction of wind, weather, etc. This consists of 52 sheets containing four printed blank diagrams, for plotting

the various observations on each day of the week from Sunday to Saturday. This calendar, we are informed, has been prepared to meet the suggestion of the Board of Education on "Rural Education," and the observation sheets are intended to be used by scholars.

The Calendar should have consisted of at least 53 sheets instead of 52, as some observers would prefer to begin the year's record on January 1, rather than on the first Sunday in the year. It is to be regretted that the "Wheel" Barometer Readings have been printed on the sheet, as they are valueless and often misleading. The character of the weather is not so much dependent on the height of the barometer as on the distribution of barometric pressure.

Manual of Tides.

The Report of the U.S. Coast and Geodetic Survey for 1907 contains Part V. of the "Manual of Tides." The other parts have appeared in the Reports for the years 1894, 1897, 1900, and 1904. The author, Mr. Rollin A. Harris, in this paper, which constitutes the concluding chapters of a Manual of Tides, treats of currents, shallow-water tides, meteorological tides, and other matters more or less connected with the main subject.

Ship Struck by Lightning.

The full title of the publication from which the note on the above subject, which appeared in the last number of "KNOWLEDGE," was derived, is the "Monthly Meteorological Charts of the North Atlantic and Mediterranean," issued by authority of the Meteorological Committee.

ORNITHOLOGY.

By W. P. PYCRAFT, A.L.S., F.Z.S., M.B.O.U., &c.

Destruction of Birds of Prey in Germany.

THE *Field* (June 6) draws attention to a scandalous crusade which is being carried on against birds of prey in Germany, instigated by the German homing-pigeon clubs. A sum of 3,500 marks has been set aside for distribution in December next in premiums for the destruction of peregrine falcons, gos-hawks, and sparrow-hawks. Of this amount, 600 marks are set aside for special premiums, to be divided among those persons who send in the greatest number of feet (in pairs), by the end of November next. Persons who deliver to the manager 20 pairs of feet will be entitled to a share of the special premiums, which are in no case to be less than 10 marks, and may be as high as 40 marks. Last year, the writer remarks, premiums were paid on 3,407 birds, of which 103 were peregrines, 1,152 gos-hawks, and 2,152 sparrow-hawks. "While fully admitting," he continues, "that the birds in question occasionally take homing pigeons, we cannot agree that the measures adopted by the Union are justifiable," and in this we most cordially agree.

Scop's Owl in Cumberland.

Mr. P. W. Parkin, in the *Field* (June 13), records the fact that he has a specimen of this bird, which was shot at Broomrigg, near Armathwaite, by Capt. W. H. Parkin, on November 6, 1907.

Sand Grouse in Berkshire.

We have been expecting to hear of the arrival of Sand Grouse on our shores, inasmuch as during May numerous flights of this remarkable bird were reported in several parts of European Russia. Mr. Hubert D. Astley, in the *Field* (June 20), reports that on June 6, a game-keeper picked up a specimen of this species in a water-meadow, bordering on the Kennet, in a very weak and emaciated condition. Though great care seems to have been bestowed upon it the bird lived only three days.

But so early as the middle of April last, it would seem a flock of Pallas's Sand Grouse were seen on the heath land round Longmoor Camp, East Liss, Hampshire.

Short-Eared Owl Breeding in Nottinghamshire.

Mr. J. Whitaker gives a most interesting account in *British Birds* for June, of the breeding of the Short-Eared Owl at Rainworth, in May last, and illustrates his remarks by a photograph of a nest which he found at the foot of a Scotch fir tree. It contained eight eggs, "upon a thickish bed of dry grasses." This, apparently, is the first record of the breeding of this owl in the county.

The Coloration of the Mouth of the Bearded Tit.

During a short holiday on Hickling Broad, I had the good fortune to see two nests containing young of the Bearded Tit. One of these, which I visited on Whit-Monday, contained six nestlings, and I took particular note of the coloration of the open mouths of these youngsters. The most conspicuous feature thereof was formed by four rows of white, conical papillæ, resembling blunt pegs, or teeth, and running down the palate on either side of the middle line. These papillæ were set in a black background, which was set off by a rich carnelion-red border, the whole being framed in, as it were, by the yellow gape.

A photograph which I took proved unsatisfactory, so I returned again two days later for another attempt, and found to my dismay that the whole family had been destroyed! Two dead and bleeding young lay in the nest, and the remaining four, more or less mangled, were found lying around the nest, one partly buried by burying beetles. Removing the nest, which had unfortunately been placed directly on the ground, and was much damaged, search was made for evidence as to the possible culprit. This seems to have been a mole. At any rate, just under the nest opened a mole-run; and further examination brought to light three well-shaped tunnels, evidently the work of this animal.

PHYSICS.

By PROFESSOR A. W. PORTER, B.Sc.

On the Electrical Resistance of Moving Matter.

THE question as to whether the earth in its motion (i) rushes through the ether, or (ii) carries it with it, or (iii) dissolves it in front and evaporates it behind, has been very much studied in recent years. The outcome of Fizeau's experiments on the velocity of light in streams of water was to indicate that these streams carried forward (with a portion only of their own velocity) the ether that was *within* them. Sir Oliver Lodge's experiments on whirling discs proved that at any rate fairly massive bodies did not sensibly move the ether *near* them. On the other hand, Michelson and Morley's experiments on aberration were interpreted as proving that the ether *near the earth* partook of the earth's motion; or in other words, whatever the motion of the ether might be at a distance, yet close to the earth it formed an atmosphere moving with it just as our aerial atmosphere does.

But again, Michelson and Morley's experiments are capable of an alternative explanation. Lorentz supposes that all bodies become shorter in the direction in which they move in the ether; and if a suitable value for this shortening be assumed, the ether may be undisturbed by the earth's motion in spite of the evidence of these experiments. This assumption of a shortening seems somewhat hypothetical; there are tempting electromagnetic reasons for thinking it may be a fact; but all possible kinds of experimental tests are necessary before one can feel assured on the question. Several attempts have consequently been made to prove (or disprove) the reality of a shortening by finding some other phenomenon which might be produced by it. Thus, Lord Rayleigh, and also Professor D. B. Brace tried to find double refraction produced just as it would be if the body were shortened by the application of pressure; the result was absolutely negative. Professor Trouton and Mr. A. O. Rankine have recently tested as

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to whether the *electrical resistance* of a body depends upon its direction with respect to the earth's motion. If a wire which is lying at right angles to the earth's motion in space be turned so that its length is now along the drift, its length would be $(1 - \beta)$, and its cross-sectional area $1 + \beta$ times the previous values, where β is a small quantity, giving the fractional alteration in dimensions. Thus, if no further change takes place, the electrical resistance, which is proportional to the length of the conductor, and inversely as its cross-sectional area, will become $\frac{(1-\beta)}{(1+\beta)}$ times its previous value, or, if β is small, approximately $1 - 2\beta$ The experiments have been made with all possible delicacy; indeed, so sensitive is the apparatus, that a change of five parts in ten thousand million could be very easily detected. No change, however, was observed except such as could be shown to be purely accidental. Lorentz's assumed value of β indicated a change of one part in a hundred million. Hence we are left in the same position as after Brace's experiments. Either the dimensions do not change, or else there is an exactly compensating change in some other property of the body. In this case it is the specific resistance which must automatically vary so as to make the change in the total resistance zero.

The shrinkage theory, in one form or another, is very popular just now. It should be understood that Michelson and Morley's experiments are the only ones which give direct support to it; *the others could be explained much more simply without it*. There is a considerable fascination in the theory, partly because of the fact that, if true, the mathematical equations can be made as simple for bodies in motion as for bodies at rest. It is doubtful, however, how far we should let simplicity of mathematical analysis guide us in our interpretation of phenomena. The doubt is intensified when it is recognised that it is only by the introduction of other changes as well as that of length that the simplicity becomes complete. To mention only that it is necessary to suppose simultaneously a change in the unit of time will show that very fundamental philosophical questions are involved in this problem; and some of us still hesitate, wondering whether there is not some less radical upheaval of our conceptions which will serve to make all the experimental facts fit in one with another. It is noteworthy that in the midst of the changes in length and time (and the other quantities, such as force and energy, which depend upon them) which are assumed to take place, the most unknown quantity itself, viz., the electric charge, is considered as being absolutely unchanged. Is it not possible that there is a way out of the difficulties in attributing variation to it alone, our fundamental notions of space and time being left undisturbed?

On the Ionisation of Air by Ultra-Violet Light.

Lenard discovered in 1900 the property which air possesses of becoming a conductor of electricity under the action of ultra-violet light of very short wave-length. The positive ions have a mobility which corresponds to that of very large ions, whereas the negative ions are very small. M. Bloch now shows by direct experiment that at any rate the greater part of the conductivity can be attributed to a photoelectric effect upon the dust suspended in the air. Even Lenard thought that this might be the case, and it is the view which Professor J. J. Thomson favours. If air is well freed from dust the conductivity (under the action of ultra-violet light) falls to a very small value. Experiments have previously been made by Langevin, which lead to the same conclusion.

Cinematographic Study of Brownian Movements.

The quantitative study of the brownian movements which very fine particles execute when suspended in fluids is very difficult, owing to the rapidity of the movements. M. V. Henri applies the cinematograph to enable measurements of such movements to be made. The particles of india-rubber in an emulsion are studied. The preparation is arranged so that only about twenty particles are visible at one time in the microscopic field, and, by means of the attached cinematograph, instantaneous photographs are taken at intervals of one-twentieth of a second. Owing to the particles being so few, their individual paths can be traced out on the photograph, and the average distances moved per second are then measured. The value obtained is about $.62\mu$ per second, and attention is called to the fact that this number is only a quarter of the value which is calculated by Einstein's formula, from the size of the particles and the viscosity of water. M. Henri concludes that Einstein's formula is inexact.

ZOOLOGY.

By R. LYDEKKER.

More Newspaper Zoology.

I HAVE more than once had occasion to refer in this column to erroneous statements on natural history subjects made in the daily press. Many of such statements are bad enough, but, I think, none comes up to the following, which appeared in the *Evening Standard and St. James's Gazette* of May 12. After referring to the fears entertained of the destruction of the forests of the United States on account of the demand for wood-pulp for paper, the writer proceeds to observe that "What the axe and the sawmill spare, the teredos, or ship's worm, attacks, laying low whole forests in its malevolent activity." For the benefit of the writer of the paragraph in question, it may be as well to mention that the teredo (not "teredos") is a marine burrowing mollusc which attacks timber submerged in the sea. In these days, when science is supposed to be publicly taught, it is nothing short of a disgrace to the nation that such a paragraph should be allowed to appear in what ranks as a high-class journal.

New Mammals from China.

A field from which new animals may still be expected is North-Western China, in the provinces of Sze-chuen and Kansu. Something has already been done in this connection by the Hon. Mason Mitchell, of the American Consular Service, by whom several skins have been sent home to Mr. Rowland Ward, of Piccadilly. The most interesting of these is the skin of a grey form of that remarkable ruminant the takin of the Mishmi Hills and Tibet. Typically, that species is a brownish animal, with a buff-coloured saddle on the back, while its previously known Tibetan and Chinese representative is golden yellow, passing into grey on the hind-quarters. According to notes communicated by the sender, the grey skin indicates, however, a totally different race, for which has been suggested the name *Budorcas taxicolor mitchelli*, in honour of the donor. Next in point of interest is the skin of a reddish coloured cat, which appears to indicate a Chinese race of the widely-spread bay-cat (*Felis temmincki*). Compared with a light-coloured skin from Sikhim, the Chinese skin is of a more distinct foxy red colour, with a narrower and more sharply defined dark dorsal line, while it apparently also indicates a rather smaller animal, for which I have suggested the name *F. temmincki mitchelli*.

Armoured Lizards and Armadillos.

In a recent issue of the *Annals* of the Carnegie Museum at Pittsburg Mr. E. Douglass describes the skull of a lizard from the Tertiary of Montana which is provisionally referred to the extinct genus *Glyptosaurus*. The whole of the upper surface of the skull is covered with small polygonal bony plates, bearing a pustular scupture. Now, it appears to me that the alleged occurrence of the remains of armadillos in the corresponding strata of France is almost certainly based on the head-plates of a lizard nearly allied to Glyptosaurus.

New Names for Old Animals.

For many years three well-known British bats, the pipistrelle, the great bat, and Leisler's bat, were almost universally designated, respectively, *Vesperugo pippistrellus*, *V. noctula*, and *V. leisleri*. Some years ago we were, however, told that the name *Vesperugo* must give way to *Pipistrellus*, when the three species became, respectively, *Pipistrellus pipistrellus* (according to the purists), *P. noctula*,

and *P. leisleri*. The next change was to remove the two latter species from *Pipistrellus*, which involved a further change of name to *Pterygistes noctula* and *Pt. leisleri*. Just as we are getting used to these names we are informed that the name *Pterygistes* is antedated by *Nyctalus*, and they are, accordingly, once more changed to *Nyctalus noctula* and *N. leisleri*. Something of the same kind has happened in the case of the long-tailed field-mouse, which, after being known for years as *Mus sylvestris*, was some time ago generically separated from the more typical mice as *Micromys sylvaticus*. After enjoying this title for a season, we are told—again on the grounds of priority—that it must be known (till next time!) as *Apodemus sylvestris*. That there will be a reaction against this constant changing (which involves a terrible and altogether unnecessary strain on the memory) I myself am fully convinced; and, perhaps, the best hope for the speedy appearance of this reaction is to be found in the ceaseless changes now proposed in nomenclature. When a really strong systematic naturalist makes his appearance, he will, I have little doubt, make short work of the innovations. Personally, I intend for the future to adopt few, if any, of them, and regret that I have accepted such changes in the past. Names that have been generally accepted for half-a-century or more, and have in many instances become almost household words, should be allowed to remain. It is not as if they could be consigned to oblivion, as they must always survive in a number of standard works. We have, therefore, to remember at least two names when one would suffice; thereby at once doing away with the whole object of systematic nomenclature, which was primarily intended to assist the memory.

Papers Read.

At the meeting of the Zoological Society held on May 12, calcareous sponges from Zanzibar and British East Africa formed the subject of a paper by Mr. C. F. Jenkin; while Mr. R. E. Turner discussed Australian digging-wasps of the family Sphegidæ; and Mr. J. T. Cunningham offered a theory in explanation of certain features in connection with the heredity of secondary sexual characters. At the meeting of the same Society on the 26th the papers down for reading, including one by Messrs. Thomas and Broughton, on Zambesian mammals, a second by the Rev. T. B. Stebbing on crustaceans from Tanganyika, a third by Mr. F. E. Beddard on the anatomy of certain marsupials, a fourth by Professor H. G. Seeley on the dermal armour of the Permian reptiles of the genus *Pariasaurus*, and a fifth by the Hon. N. C. Rothschild on new fleas.

REVIEWS OF BOOKS.

ASTRONOMY.

Annals of the Astronomical Observatory of Harvard College, Vol. XLVII., Part I. A Photographic Study of Variable Stars. Vol. LVII., Part I. Observations of 75 Variable Stars of Long Period During the Years 1902-1905. Vol. LX., Nos. IV. and V. 1,777 Variables in the Magellanic Clouds, and 10 Variable Stars of the Algol Type. Vol. LXII., Part I. Determination of Constants for the Reduction of Zones Observed with the Meridian Circle during the Years 1888-1898.—The activities of Harvard College Observatory are manifold, and yet there is no lack of appropriateness in the great preponderance of photometry in the above list of recent publications, for that particular subject, with many ramifications, is certainly the one with which the observatory has been most closely associated. Last in the list comes the preliminary volume of the additional zone catalogue, undertaken by Harvard College, extending roughly from 10 to 14 degrees south of the equator; the term "additional" bearing witness to the fact that the same observatory was a sharer in the original Astronomische Gesellschaft programme, having undertaken in 1870 the zone 50 to 55 degrees north of the equator. This part of the work comes under the immediate supervision of Professor Searle. Mrs. Fleming is responsible for the first publication in the list, which forms part of the Draper Memorial work which she superintends, and contains measures from photographs of 222 variable stars discovered during that work, with an interesting description of the method employed and the precautions taken. Of perhaps more general interest are the portions of Vol. LVII. and Vol. LX., prepared respectively by Leon Campbell and Henrietta S. Leavitt. The first of these deals with 75 long-period variables kept under constant observation for a few years, including such well-known stars as Mira Ceti and χ Cygni, and is accompanied by plates showing light curves classified under five headings—Broad Maxima, Broad Minima, Rapid Increase, Rapid Decrease, and Uniform Variation. Of the latter volume one part deals with the extraordinary number of variables discovered in the Magellanic clouds, and gives two fine plates of these regions, impressed with "réseaux," and the other with ten variable stars of the Algol type, accompanied by a fascinating series of light curves as well as a print of one of the Harvard plates, 30 degrees square, of which a series of 55 covers the entire sky, and which form an invaluable record, being repeated almost automatically at such frequent intervals that they provide an almost infallible test for "new" or "variable" stars. Professor E. C. Pickering is much to be congratulated on the continued activity of the great institution of which he is the Director.

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Types and Breeds of Farm Animals, by C. S. Plumb (London: Ginn and Co., 1906; pp. x. and 563, illustrated; 8s. 6d. net).—Although written from the American rather than from the English standpoint, there is plenty of room in this country for this well-written and beautifully illustrated volume, which has the great merit of being thoroughly up-to-date and including the results of the most recent investigations into the origin of many of our breeds of domesticated animals. Unless it be that the term "farm" has a wider signification in America than on this side of the Atlantic, the title of the work scarcely seems to do justice to its contents, as it is surely somewhat of a "terminological inexactitude" to speak of Arabs and thoroughbreds as farm animals. Be this as it may, the book includes longer or shorter notices of all the more important breeds of horses, cattle, sheep, goats, and pigs kept in Western Europe and the United States, together with mention of the ass and the mule. Special value attaches to the account of the origin of our thoroughbred horses, but we rather wonder why the ancestry of the horse should have been given at length, when no reference appears to be made to the descent of our cattle from the extinct wild ox. An excellent feature is the division of cattle and sheep into distinct groups according as to whether they are bred for the butcher, or the one for milking and the other for wool. Among the illustrations of cattle we have been much struck with those of the Dutch belted breed, in which the colour is black save for a broad white belt round the middle of the body. Every person who has anything to do with horses or farm-stock should order a copy of this book forthwith.

BOOKS RECEIVED.

The Fundamental Conceptions of Chemistry. By Prof. S. M. JÖRGENSEN. Manuals of Elementary Science Series. (London: S. P. C. K., 1908, pp. 170, 2s. 6d.)

The Royal Gardens, Kew. By E. J. WALLIS. (London: E. J. Wallis, 1908, pp. 64, 1s. net.)

Cancer: Operation Not the Cure but a Cause. By J. SHAW, M.D. (London: "The Pilot" Press, 1908, pp. 144, 1s. net.)

The Rise of Man. By C. R. CONDER. (London: John Murray, 1908, pp. 357, 12s. net.)

La Télégraphie Sans Fil. By Prof. E. GUARINI. (Paris: Dunod & Pinat, 1908, pp. 196, 4 francs.)

Good Health. Parts I. and II. By F. H. SHOOSMITH. (London: Charles & Dible, 1908, each pp. 48, 2d. each.)

The Licensed Trade, an Independent Survey. By E. A. PRATT. (London: John Murray, 1908, 3rd edition, pp. 384, 1s. net).

A New French-English English-French Pocket Dictionary. By DE V. PAYEN-PAYNE. (London: Cassell & Co., 1908, pp. 220, 1s. 6d. net.)

The Little Naturalist at the Seaside. By the Rev. THEO. WOOD, F.E.S. (London: E. Nister, 1908, pp. 112, 1s.)

Essays Political and Biographical. By Sir SPENCER WALPOLE, K.C.B. (London: T. Fisher Unwin, 1908, pp. 306, 10s. 6d. net.)

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MICROSCOPY

Conducted by F. SHILLINGTON SCALES, B.A., F.R.M.S.

The Preparation of Microscopical Objects.

(*Continued from page 140.*)

Unfortunately, paraffin infiltration is a somewhat lengthy matter, and it will be evident that the variations in temperature must be within very narrow margins. It is therefore necessary to carry out the process on a water-bath, or water-oven, provided with a gas-burner and regulator, neither of which need necessarily be very costly. A fairly efficient bath can be fitted up out of an old potato steamer, some test-tubes, and a thermometer, as mentioned by Mr. M. J. Cole, but this would want tedious watching for proper infiltration. The simplest and cheapest regulator is made on Page's principle, and consists of a large tube partly filled with mercury, immersed in the water of the bath. The end of the tube is closed with a cork, and through this a smaller tube with its end cut diagonally, is inserted so that it lies inside the large tube, and in contact with the mercury. The gas enters the larger tube by a side branch, and goes out through the smaller inner tube, the end of which lies in the mercury, but is not quite closed by it. A little adjustment for the requisite temperature, measured by a thermometer in the water-bath, is necessary, and then as the mercury expands with any rise in temperature it will more or less close the end of the inner tube and so reduce the amount of gas which is fed to the burner. I have left one of these regulators unattended for many hours and have not found the temperature of the water-bath vary by more than a degree or two.

The transference of the object from the clearing agent to the melted paraffin may be done gradually, as, for instance, by using an intermediate mixture of paraffin and xylol in equal proportions, but generally speaking, unless there is a disproportionate amount of clearing agent, it is quite sufficient to transfer the tissues at once from the clearing agent (draining off any excess) to pure paraffin, which has been slowly melted beforehand. The paraffin is then kept melted in the water-bath, at the requisite temperature for a time varying from an hour to several days, until it is thoroughly infiltrated. Mr. Lee has a very good working rule by which to judge the time. He gives rather longer than was required to clear the object in the clearing agent. Two hours is a fair average, but a longer time than is necessary is apt to damage the tissues. The paraffin should be kept covered to avoid water-vapour as well as dust. With cedar-oil as clearing agent, a change of paraffin is often necessary, and sometimes two changes, but xylol seldom requires any change. Very transparent objects may need to be stained before infiltration, or to be faintly coloured with a temporary stain, such as Bordeaux red, to enable them to be seen in order to orientate them.

When the tissue is thoroughly infiltrated, the paraffin must be poured into one of the paper-boxes or other moulds already referred to, the object being then transferred, and held in position by needles or fine forceps. As soon as the paraffin shows signs of cooling by becoming opaque, it must be at once floated on to cold water, as it is of importance that it should cool rapidly, or it will crystallize in large instead of small crystals and will not section so well. Air-bubbles may be a great nuisance, and the rapid cooling also tends to prevent their formation. The water must not come into actual contact with the paraffin itself.

(*To be continued.*)

Royal Microscopical Society.

MAY 20, A. N. Disney, Esq., M.A., B.Sc., in the chair. Mr. Rousselet showed upon the screen a series of lantern slides of the microscopes of historical interest which the Society is exhibiting at the Franco-British Exhibition. Mr. Rousselet, the Curator, gave a description of each instrument, and said that the exhibit consisted of 28 microscopes, mostly taken from the Society's collection, with others lent by Sir Frank Crisp and Mr. E. M. Nelson, illustrating the history of the microscope. It included a model of Leeuwenhoek's microscope, date about 1673, microscopes by Musschenbroek, 1702, Wilson, 1702, Culpepper, before 1738, Lieberkühn, 1738, John Marshall, 1744, John Cuff, 1744, Benjamin Martin, 1760, and one made for George III., 1771, Dellebarre, 1777, Jones's "Most Improved," 1798, Lister-Tulley, 1826, Cuthbert's reflecting microscope, 1827, Chevalier, 1834 and 1840, Hugh Powell, 1839 and 1841, Jas. Smith, 1841, Andrew Ross, 1842, Dr. Edwin Quekett, 1844, and Powell and Lealand, 1848. Mr. J. E. Barnard exhibited and described an old photo-micrographic apparatus, designed by Dr. Maddox, for Dr. Lionel S. Beale, which was of interest, in having an arrangement between the objective and stage to exclude extraneous light, and in having the illuminating apparatus carried on a triangular bar with its apex inverted, thus losing the advantage of the principle of the triangular bar. A large number of specimens of pond life were exhibited towards the close of the evening, by Fellows of the Society, kindly assisted by Members of the Quekett Microscopical Club, by means of between 30 and 40 microscopes.

Quekett Microscopical Club.

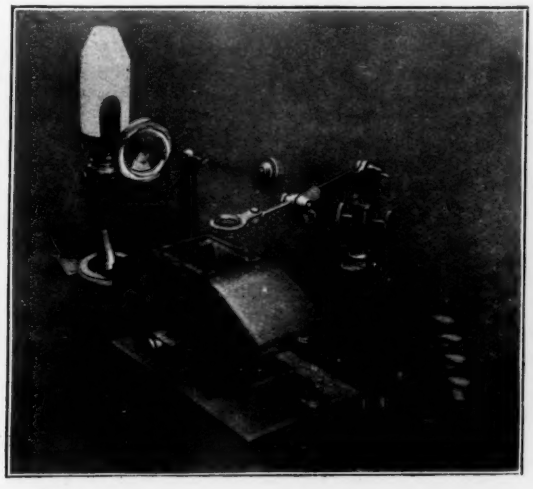
May 15. Mr. C. Lees Curties, F.R.M.S., exhibited and described the simple form of apertometer suggested by Mr. F. J. Cheshire, F.R.M.S., and a mercury-vapour lamp, adapted for use with the microscope. The superiority of the mercury-vapour lamp was well shown by a preparation of *A. pellucida*, which was resolved into lines when illuminated with the ordinary oil lamp, but these lines were further resolved into distinct dots when the mirror was adjusted to receive light from a mercury-vapour lamp. Mr. R. T. Lewis, F.R.M.S., exhibited and described a number of preparations of insects, mostly of those of especially brilliant colouring. The President, Professor E. A. Minchin, exhibited and described a preparation demonstrating the existence in the spicules of calcareous sponges of an axial filament of organic matter.

Mr. F. Martin-Duncan, F.R.P.S., gave a lecture, very fully illustrated with lantern photographs, dealing with insect life.

Mechanical Stage for Dissecting Microscope.

Mr. Ernest Heath, of Cardiff, writes:—"For some considerable time I have found in using the dissecting microscope, that it is very much easier and simpler to move the material backwards and forwards under the lens, than to move the lens over the material on the swinging arms provided with most dissecting stands. This is more especially so when working by lamplight and with a condenser, as frequently the position of these has also to be readjusted.

"About a year or so ago, I constructed a movable stage from wood, actuated in two directions at right angles by screws, but the condition of the atmosphere rendered the screws difficult to work by reason of the wood slides, in which the apparatus moved. I then had some brass castings made, and these were completed some three weeks ago, and the whole thing works admirably.

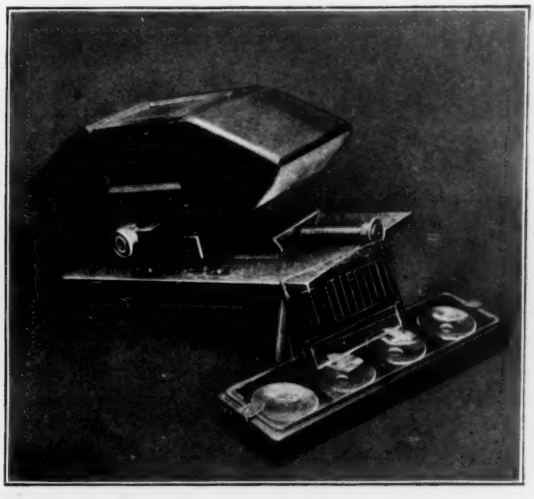


"As will be seen from the photographs, the mechanical stage consists of two slides, similar to the slide-rest of a lathe, working at right angles with one another and actuated by screws. The top plate of the upper slide is let into and screwed firmly to the underside of a Barnes Dissecting Stand, made by Messrs. Bausch and Lomb. This works three inches in either direction. On the top of the glass stage I place (for Foraminifera, which is my particular study) a glass tray, made of a double thickness of glass, cemented together, leaving on the bottom side a trough for sweeping the selected forams into. The top plate has on the underside, before being cemented, twelve lines, a quarter of an inch apart, and one inch in length, cut in with a diamond. These form guides to work by when under the lens. This can be seen more distinctly in the second photograph, where it is placed against the stand. I work up one line, then traverse across to the next, and in this way the material to be looked over is thoroughly searched without missing any of the ground. The lens-holder is one of Bausch and Lomb's T.U.S. holders, which is easily adjustable to almost any height, and focusses easily with a diagonal rack and pinion. With a x-20 lens the field taken is about halfway between the two lines, whilst a x-10 takes in very comfortably the space between the two lines.

"The Foraminifera, which are collected in the little trough of the tray, are then brushed into one of the watch glasses, shown in the little box holding four glasses, and are put on one side till the mounting time comes round, which is generally when about sixty glasses have been used.

"Of course, it is very necessary that the slides should be accurately planed, scraped, and fitted together, so as to ensure their working quite smoothly. The bottom screw should be of a good deal coarser pitch than the top one, as this is required to work quicker, not being used under the lens.

"The little tray for picking out Foraminifera, already alluded to, I made some two or three years ago and have worked with it ever since. Of course, it is used over a dark-ground plate, and I think I may safely say that the use of it increased the speed in



picking out Foraminifera from my gathering fully 100 per cent. As can be seen from the second photograph, it consists of five pieces of glass cemented together, the base piece being $3\frac{1}{2}$ by $2\frac{1}{2}$ inches; the upper top-piece, on which the guide-lines are cut with a diamond, being about $3\frac{1}{2}$ by $1\frac{3}{4}$ inches, with the lower edge bevelled. The lower piece is 3 by $\frac{1}{4}$ inches, with the top edge bevelled, and two small pieces about $\frac{3}{4}$ by $\frac{1}{4}$ inch form the two ends to the trough, which is about 3 by $\frac{1}{2}$ inches. These two sides have not bevelled edges, as it is sometimes convenient when the Foraminifera are reluctant to leave the bristle, to have the square edge to scrape them off with. In working the larger grades they are pulled off the tray with a fine wire, bent to a half-hook, and mounted on a needle-holder. With a good gathering I have often got over 1,000 forms in about an hour.

"The little cases to hold the watch-glasses are very convenient, as one can store away any number of these with picked material without dust getting in, as they are all fitted with glass covers with ground edges."

[Communications and inquiries on Microscopical matters should be addressed to F. Shillington Scales, "Jersey," St. Barnabas Road, Cambridge. Correspondents are requested not to send specimens to be named.]

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The Face of the Sky for July.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 3.49 and sets at 8.18; on the 31st he rises at 4.24 and sets at 7.49. On the 2nd at 7 p.m. the earth is at its greatest distance from the Sun, the solar parallax then reaching its minimum value of 8″·66.

On account of the declining solar activity, sun spots and solar prominences are not very numerous.

The positions of the Sun's axis, equator, and the heliographic longitude of the centre of the disc, are shown in the following table:—

Date.	Axis inclined from N. point.	Centre of Disc N. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
June 29 ..	3° 32′W	2° 48′	144° 48′
July 4 ..	1° 15′W	3° 21′	78° 37′
,, 9 ..	1° 2′E	3° 52′	12° 26′
,, 14 ..	3° 17′E	4° 22′	306° 17′
,, 19 ..	5° 30′E	4° 50′	240° 7′
,, 24 ..	7° 39′E	5° 16′	173° 58′
,, 29 ..	9° 46′E	5° 40′	107° 50′

THE MOON:—

Date.	Phases.	H. M.
July 6..	☽ First Quarter	8 25 p.m.
,, 13..	○ Full Moon	9 48 p.m.
,, 20..	☾ Last Quarter	0 2 p.m.
,, 28..	● New Moon	7 17 a.m.
July 2..	Apogee	4 48 p.m.
,, 15..	Perigee	0 48 a.m.
,, 30..	Apogee	3 12 a.m.

OCCULTATIONS.—The following occultations are visible at Greenwich before midnight:—

Date.	Star's Name.	Magnitude.	Disappearance.		Reappearance.	
			Mean Time.	Angle from N. point.	Mean Time.	Angle from N. point.
			p. m.		p. m.	
July 12	24 Sagittarii	5·9	9·48	19°	10 5	352°
,, 16	τ^2 Aquarii	4·3	10·59	76°	12 3	243°

THE PLANETS.—Mercury (July 1, R.A. 7h 1m; Dec. N. 18° 35′; July 31, R.A. 7h 23m; Dec. N. 21° 19′) is in inferior conjunction with the sun on the 4th; towards the end of the month the planet is a morning star in Gemini. On the 25th Mercury is at "greatest westerly elongation" of 19° 50′; on this date the planet rises at 2.44 a.m. or 1½ hours in advance of the Sun.

Venus (July 1, R.A. 7h 10m; Dec. N. 19° 31′. July 31, R.A. 8h 23m; Dec. N. 17° 14′) is in inferior conjunction with the Sun on the 6th, hence during the former part of the month the planet is unobservable. Towards the end of the month the planet is a morning star in Gemini rising about 1½ hours in advance of the Sun on the 24th.

Mars (July 1, R.A. 7h 52m; Dec. N. 22° 8′. July 31, R.A. 9h 11m; Dec. N. 17° 29′) is for all practical purposes unobservable as he sets only about one hour after the sun and shines very feebly, his apparent diameter being only 3″·6.

Juno (July 4, R.A. 18h 48m; Dec. S. 4° 48′) is in opposition to the Sun on the 4th; the magnitude of the minor planet on this date being 9·4.

Jupiter (July 1, R.A. 9h 9m; Dec. N. 17° 13′. July 31, R.A. 9h 33m; Dec. N. 15° 19′) is practically out of range of observation, except during the first week of the month, when he may be seen low down in the North-West portion of the evening sky; on the 15th the planet sets at 9.18 p.m., or about an hour after the Sun.

The satellites are practically unobservable in consequence of the planet being in a bright part of the sky.

Saturn (July 1, R.A. 0h 40m; Dec. N. 1° 43′. July 31, R.A. 0h 41m; Dec. N. 1° 42′) rises about 11 p.m. near the middle of the month, and is in quadrature on the 2nd. The planet is situated in Pisces; the ring as seen in the telescope appears fairly open, the southern surface is visible and inclined to our line of vision at an angle of 8°.

Uranus (July 15, R.A. 19h 4m; Dec. S. 23° 4′) is in opposition to the Sun on the 7th, hence about this date he appears due South at midnight. The planet is situated about 2° South of the star π Sagittarii, and although rather low down is otherwise well placed for observation. Its remarkable spectrum of broad dark bands is well worth the attention of observers, even though possessing only small instruments.

Neptune (July 15, R.A. 7h 4m; Dec. N. 21° 52′) is not observable this month, being in conjunction with the Sun on the 7th.

METEOR SHOWER.—The most notable shower in July is that of the δ Aquarids, which occurs on the 28th. The radiant is situated in R.A. 22h 36m, Dec. S. 11°, and the meteors are slow with long tails.

TELESCOPIC OBJECTS (Double Stars, &c.):—5 Serpentis, XV.h 13m, N. 2° 13′, mags. 5·1, 10; separation 10″.

β Serpentis, XV.h 41m, N. 15° 44′, mags. 3·8, 10; separation, 31″.

θ Serpentis, XVIII.h 51m, N. 4° 4′, mags. 4·0, 4·2; separation, 21″·6. Both are yellow, the primary being paler than the smaller star.

ξ Cephei, XXII.h 1m, N. 64° 8′, mags. 4·7, 7; separation, 6″.

δ Cephei, XXII.h 26m, N. 57° 56′, mags. 4·2, 7; separation, 40″. A pretty pair for small telescopes, stars respectively yellow and blue. It is also a typical short period variable star, not of the Algol type, the period being 5d 9h, with a sharp rise from minimum to maximum in 1d 9½h. There will be a minimum on the 16th at midnight, from which other minima and maxima may be calculated from the intervals given.

Cluster in Libra, M 5. A compact cluster situated about one-third of a degree North of the double star 5 Serpentis; it appears like a large nebulous star when viewed with a pair of opera glasses.

Cluster in Serpens, N.G.C. 6633; about one-third of the way from θ Serpentis to α Ophiuchi. The cluster is visible to the naked eye.

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